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Lower Carboniferous Limestone.

MOUNT RADIANCE, JERSEY LANDING,

VIEW LOOKING NORTH

GEOLOGICAL SURVEY OF ILLINOIS.

A. H. WORTHEN, DIRECTOR.

VOLUME V.

GEOLOGY AND PALÆONTOLOGY.

GEOLOGY,

BY A. H. WORTHEN AND JAMES SHAW.

PALÆONTOLOGY,

BY F. B. MEEK AND A. H. WORTHEN.

PUBLISHED
BY AUTHORITY OF THE LEGISLATURE OF ILLINOIS.
1873.

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TO HIS EXCELLENCY

THE HON. JOHN L. BEVERIDGE,

GOVERNOR OF THE STATE OF ILLINOIS.

SIR:

I have the honor of submitting herewith, for publication, the fifth volume of my report on the Geological Survey of Illinois, in accordance with the provisions of an act of the Twenty-seventh General Assembly, approved April 3d, 1872.

As soon as practicable after the passage of the act above named, contracts were made for engraving the plates for this volume, and this part of the work is now so nearly completed that the printing need not be longer delayed.

I have the honor to be

Your obedient servant,

A. H. WORTHEN.

GEOLOGICAL ROOMS,
Springfield, Illinois, June, 1873.

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CHAPTER I.

GEOLOGY OF NORTHWESTERN ILLINOIS.

That part of the State of Illinois embracing the valley of Rock river, and thence north and west of the same, and more minutely described in the following detailed county reports, is, geologically, agriculturally, and in a manufacturing point of view, one of the most interesting portions of our great State. The valley of Rock river, if indeed the high rolling prairie on either side can be called a valley, in fertility and beauty of prairie land, is perhaps unequalled in the West. The river itself—swift flowing, broad, clear as crystal—affords one of the most magnificent water powers in the world. At Camden, Sterling, Dixon, Grand DeTour, Oregon, Rockford, Rockton, and Beloit, excellent dams are already built and extensively used for milling and manufacturing purposes. Others will be built in due course of time. Almost every half dozen miles contains one or more of these heavy water powers. At one end of the stream are the lumber regions of Wisconsin; at the other, the coal fields of Rock Island. On either side is the richest agricultural region in the State. Along the banks and in the bed of the river are many kinds of stone from the best Silurian formations. A railroad up the valley, joining the coal and lumber, will be built at no distant day.

In addition to this, the Government survey of Rock river, made under charge of General WILSON, and submitted in the form of a report to the War Department some four years ago, shows that the improvement of Rock river navigation by slack water dams from Rock Island to Lake Horicon, thence across to Lake Winnebago, and thence down Fox river in Wisconsin to Lake Michigan, is not only a feasible project, but is full of interest to the people of this valley and to the whole North-west. It will thus be seen that Rock river and its valley, in their present and prospective resources, salubrity of climate and beauty of location, have not their equal in the State, or perhaps in the nation. The geological formations along the stream are also of an interesting character. The section of the river bluffs herewith presented, and the following county reports, contain detailed descriptions of these formations.

At Beloit and Rockton the dull, yellowish earth-colored buff limestone, with its bands of dark blue, is the surface rock; half way to Rockford this formation sinks below the upper division of the Trenton; three miles above Rockford, and at the city, the warm cream-colored Galena limestone outcrops in the river bluffs to the highth of one hundred feet; lower down the Galena gradually thins out, until the buff again comes to the surface in a low axis at Byron. From Oregon to Grand DeTour the castellated hills of the St. Peters' sandstone, shining white, brown, and flame-colored in the sun light, and rising to an elevation of nearly two hundred feet, form striking and picturesque objects in the landscape; below these the solid Lower Magnesian limestone probably forms the floor of the glancing river. At Dixon two divisions of the Trenton may be examined almost side by side for some distance; at Sterling the green and blue shales of the Cincinnati group, and the chert-banded and dendrite-speckled Niagara limestone outcrop heavily in the same quarry; from Sterling to Erie, and even lower down, the Niagara continues in the bed of the river and in its banks, a low outcrop, changing before it runs under the Coal Measures into a softer, whiter, finer grained stone, formerly called the LeClair limestone; from a few miles below Erie to Camden, the gently rounded hills and black limestones of the productive Coal Measures rise to varying elevations; from Camden to the Mississippi the river rushes over a smooth floor of solid dove-colored Hamilton limestone of Devonian age.

That part of the State between Rock river and the Mississippi, except Jo Daviess and a part of Carroll counties, is mostly high, rolling prairie land, dotted with beautiful groves of timber, and abounding in many small streams, which afford good mill seats and light water powers. The soil is dryer than the flat prairies of Central Illinois. The portion above excepted, being within the productive lead basin, is more abrupt and broken.

The agricultural and horticultural productions, kinds of timber, mineral wealth, superficial extent of geological formations, soils and their capabilities and adaptations, and other matters of scientific and economical interest, will be found set out in detail in the county reports following this article, but need not be again repeated in this place.

The Mississippi river on the west exposes a fine section of its rocks from Dunleith to Rock Island. At the latter place the Hamilton limestones and Coal Measures both outcrop and are the prevailing rocks as far up as Moline; from thence to the south line of Carroll county massive walls of Niagara limestone in places appear like vast mural escarpments, bounding the broad Mississippi bottoms on the east; about Bluffville the Cincinnati shales and clayey limestones are the predominating rocks; at Savanna the same Cincinnati group is capped with more than a hundred feet of coarse, reddish-brown Niagara limestone; and as we ascend towards the north line of the State, massive, solid Galena outcrops occur, the famous lead producing rocks of the North-west.

Leaving these rocky formations for the present, it may be well to discuss some questions connected with the superficial deposits covering them.

If all the soils, clays, sands, and gravels, and other loose materials spread over the face of the country were removed, the probability is that the rocky surface thus displayed, would present valleys of erosion and elevated ridges; but these inequalities would not perhaps be greater than those now appearing on the surface.

The glacial drift period, and the tremendous forces acting through it, are not well understood by geologists, but they had much to do with the deposition and present arrangement of the loose materials, covering the rocks concealed beneath them.

Clays, sands, and their various mixtures, are originally derived from the decomposition of the primitive rocks. The silent processes of nature, to-day, as in past geological time, are grinding rocks into clays and sands, and re-cementing clays and sands into rocks. The affinities of rocky matter can be destroyed by atmospheric and chemical agencies, but the elements will still remain.

There are two theories as to the deposition of the loose materials covering the rocks in this part of the State. One is, that they are derived from the slow decay of the underlying rocks, leaving the clay *in situ* in the exact places where the rocks rotted away. The other is, that the drift forces mingled, mixed, and deposited these loose materials, having gathered them from long distances, and from many and widely separated sources.

In the part of the State now under consideration, evidences of the truth of both these theories can readily be found. In the productive lead region it is now conceded that the drift forces did not act at all, or acted in a modified form. The productive lead rocks are covered by a peculiar reddish clay, derived in large part, I think, from the decay of the upper strata of the rocks. It bears little evidences of mixing or transporting agencies. The top is enriched by vegetable and atmospheric influences, and has become a thin, poor soil. As it is penetrated, it becomes a reddish clay; pieces of float mineral are found, sometimes in considerable quantities, and before the solid strata are found, apparently lying *in situ*, unworn by water, and becoming more numerous, until the solid rock is reached, as if they were harder fragments of the original rocks, which have withstood the general decay of the mass.

Fragmentary patches of the lead region are undoubtedly driftless regions, but in many places the drift has invaded the lead regions. In the north-western portions of Carroll county, where the indications are strong that the soils and clay are derived from the decomposition of the underlying rocks, fragmentary boulders are often found on the surface of the ground and in the ravines, showing, as it seems, that even these driftless lead regions have been submerged, perhaps many times, since their uplift from the Silurian seas.

The finely comminuted, greenish and creamy yellow colored clays, forming the subsoil over small extents of North-western Illinois underlaid by the Cincinnati shales, would seem to indicate an origin from the decomposition of the earthy shales below.

But in many places and over large extents of this part of the State, the transportation of soils and clays, and a universal mingling and mixing of the surface materials of the earth, is a fact patent to the most casual observer. The gravel hills of Ogle county, and the long gravel beds of Winnebago and Boone counties, mingled with white sand; the stratified and partially stratified clays and sands to be met with almost everywhere; the boulders scattered over the prairies—all owe their present arrangement to the drift forces. Over these places the underlying rocks are hidden by the concealing drift. Laminated clays cover the indurated rocks. These clays are in some cases nothing but the sediments and precipitates of peaceful, shallow seas; but the boulders and gravel beds indicate mightier forces and belong to the true glacial drift. That vast glaciers of ice once extended over large portions of North America is now universally conceded. Their slow, crawling motion and irresistible force ground the rocks to powder, as wheat is ground to flour between the upper and nether millstones; not only ground them to powder, but rounded and polished the boulders and the gravel, planed and grooved the rocky surface of the earth, and moved the vast masses of drift materials from place to place in a slow procession. Direct evidences of the ice forces of the glacial period are not met with so frequently, as a modified form of these forces. Along the ridges and gravel hills north of Foreston, in Ogle county, the great accumulation of gravel, sand and boulders, presents the appearance of glacial moraines, as if two glaciers had met and deposited their accumulated loads of dirt, sand, gravel and boulders, much of which seems to have been torn from rocky formations of the Silurian age, at no great distance from the place of final deposit. But the great mixing and transporting agency which arranged, assorted, and deposited most of our Northern Illinois drift deposits, was evidently the mixed action of ice and water.

When the temperature of the glacial winter began to grow warmer, and the great moving fields of ice began to melt, streams of turbid water would rush out and form shallow seas and lakes. The glaciers on the more elevated portions of the land, still fed by perpetual snows, would creep into the neighboring bodies of water, break off and float away in the form of icebergs and floes, bearing with them the boulders, gravel and dirt, torn from the hills and outcropping rocks along their passage. As this floating ice melted, either by an increase of the earth's temperature, or by being borne into a warmer atmosphere further south, the materials with which it was freighted would sink to the bottom, and become subject to the action of a new force, the assorting and transporting force of currents of flowing water. The contraction and expansion of the ice over these shallow lakes or seas, caused by alternate freezing and thawing, also exerted a powerful influence in tearing loose stones from the neighboring banks and piling them into long heaps and gravel beds. In some of the lakes in Northwestern Iowa the frost power is producing wonderful phenomena, giving rise to the popular error of walled lakes.

Thus it will be seen that the first and greatest of the drift forces was the glacier; then the floating iceberg and ice field produced their results, carrying the large boulders from place to place, and dropping them over the ice cold seas; and last, the wave and current forces of water, after the ice had in part, or altogether melted, left the loose clays, sands and subsoils, substantially as we find them now.

Arctic travelers have made us somewhat familiar with the desolations and savage beauty of the North polar regions—home of the icebergs, land of the glaciers, and realm of enduring frost. The phenomena there witnessed at the present day are exactly similar to the ancient forces acting over these prairies, as I have above attempted to describe them, except in so far as they were modified by the leveler nature of this country as compared with snow-bound, ice-locked Greenland.

The icebergs rise cathedral and sphinx-like from the bosom of the fiords and inland seas, making an ice forest in places over the watery wastes. They impinge upon each other with the crash of parks of artillery, and float away on gulf streams and melt in warmer latitudes, strewing the floor of the ocean with their adhering earth and stones. The blaze of the arctic summer sun lights them up into brilliant colors. Peaks of flame, columns of emerald, sapphire and blue, move slowly over the green waters, and the play of prismatic colors is indeed beautiful in all the reflected and refracted changes of the bergs. Glaciers are creeping slowly down from the neighboring mountains: fed at their upper ends with perpetual snows: their lower ends constantly breaking off in the waters, and sending away fields of ice and icebergs, loaded with the debris and stones collected in the downward journey.

Similar phenomena, perhaps in a modified form, were once displayed over all the regions traversed by the drift. The ice gradually melted away, commencing south and disappearing up to the arctic regions. In process of time the waters gave place to the dry land, and our northern prairies remain, moulded into gentle undulations by the fingers of the retiring waves.

The startling theory of the Ice Period in North America, announced by Professor AGASSIZ in the *Atlantic Monthly* for July, 1864, at that time was almost too much for the faith or credulity of scientific men. Now, a large portion of the scientific world accepts the theory then announced. In his recent expedition in Brazil and up the Amazon, the traces of a great glacier, filling the whole valley of that large river, were discovered. When such a sea of ice existed under the very tropic skies, this world must indeed have been in the midst of a glacial winter, where snows, and frost, and ice held supreme sway. We wonder if, then, the progenitors of the mound builders and ancient copper miners and workers, built their snow and ice huts, and moved about in their light kiyaks, as the Esquimaux of to-day do in frigid Greenland!

The influence of these glacial drift forces upon soils is worthy of a passing thought. They changed the surface of the earth from its conditions during the Carboniferous ages; and made soils, by the processes above enumerated, fit to produce grasses, grains, fruits, and hard wood trees. They prepared the earth for civilized man.

In this part of the State, in attempting to classify soils and earths thus mingled and made, there is no end to the distinctions and classifications. Soils are light or heavy, warm or cold, dry or wet, compact or porous, fine or coarse, hungry, leachy, loamy, sour, sweet, clayey, sandy, limey, marshy, peaty, and various combinations of these, too numerous to mention. Silica, or the earth of flints, alumina, lime, magnesia, potash, and various salts and metalloid compounds, unite in chemical or mechanical combinations to make up these soils. The humus or gein, which gives richness and fatness to the land and blackness of color, is chiefly derived from successive growths and decays of grasses and other vegetation.

The productiveness of these soils depends not alone on the nature of the soils themselves, but also upon climatic and atmospheric influences, and the nature and properties of the sub-soils and underlying drift materials. If the subsoil is gravelly, marly, leachy or porous, so as not to retain too much moisture, fruits and cereals will flourish. If a hard pan or impervious clay lies under the soil, so as to retain the surplus moisture, corn and grasses will perhaps do better. The practical agriculturist will knock the bottom out of such a soil if he can, by deep plowing or underdraining, so as to let the surplus water leak out, and permit the sunbeams and kissing winds to penetrate and sweeten the land.

Not only the agriculturist, but the horticulturist may learn a lesson from this. In the first place let him select one of nature's orchard spots, if that be possible, on which to plant his trees and vines. A light soil, porous sub-soil, sheltered sunny exposure, and well drained slope or hill side, is the favored spot. Then let him plant, in proper season, of the best and hardiest varieties, in holes big as little cellars. Take care of the young trees, feed them with fertilizers and good cultivation, wage war with their insect foes, and in due time an abundant fruitage, even in this climate, will be the result.

If nature has not given him an orchard site, then he must make one. Do artificially what nature has failed to do. Drain and underdrain, plow and sub-soil plow, manure and feed with fertilizers, plant shelter belts to modify and sift the blistering winds, and in this way an orchard or vineyard may be made to grow, whose generous fruitage will more than repay the expense and toil.

But, leaving these topics, which belong rather to practical agriculture and horticulture than to geology, I pass to notice some phenomena more particularly discernible along the small streams between the Mississippi and Rock rivers. There are a number of these large creeks and small rivers, referred to in the county reports. Those crossing the face of the country in an eastern or western direction, generally have the strata along the north side of the stream, elevated higher than those on the south side. In some instances the stream is the dividing line between an older and more recent formation. The Cincinnati shales and limestones often underlay the level prairies on the south side, up to the very water's edge; while the country on the north side rises in rather bold outcrops of the Galena limestone. I think the streams are oftener than otherwise the dividing line between different groups and formations.

Closely connected with this phenomenon is another. The streams often seem to flow in fissures or cracks of the underlying rocks. Slow upheavals, and slight contractions in the cooling earth perhaps, made these fissures. In time they filled partially, making the narrow bottoms and the beds of the present streams. Slight faults were thus left, which seem to be bounded by the streams, and fully account for the difference of elevation on different sides of east and west streams.

While speaking of the surface geology of the region between the two rivers, a few words as to the origin and formation of the prairies, may not be out of place.

The largest portion of this part of the State is prairie land. In it all kinds of prairies may be seen, such as the high upland prairies, the river bottoms or alluvial prairies, and the low, wet swamp lands.

There is quite a diversity of opinion as to the origin and formation of these treeless and grass-covered regions of the

North-west. One theory attributes them to annual fires sweeping through the grass, and killing every tree, germ and young tree, almost before they could take root. In some places the fires are supposed to have encroached year by year upon the forests; in other places, as for instance along the streams, in the deep hollows, or in wet places, where the fires would be checked, the timber would spring up and displace the prairies. Another theory accounts for the treeless character of these plains, from the lacustrine origin and nature of the prairie soils and sub-soils. Trees will not naturally grow in this sedimentary, finely comminuted prairie soil, according to this theory. Others attempt to explain prairie phenomena by atmospheric and climatic influences, marking out certain zones of moisture and dryness. They bound forests and prairies by certain isothermal lines. Another theory, advocated with force and plausibility by Professor LESQUEREUX, in the first volume of the Geological Reports of this State, finds all our prairies to originate from causes similar to those which form peat beds, and are in fact incipient peat beds, drained before completed. In his own clear language he finds "that all the prairies of the Mississippi valley have been formed by the slow recession of sheets of water of various extent, first transformed into swamps, and by-and-by drained and dried. The high rolling prairies, the prairies around the lakes, those of the bottoms along the rivers, are all the result of the same causes, and form a whole in an individual system."

No one of these theories is sufficient to explain all the phenomena noticed in making an examination of the prairies. As in most such cases in theoretical geology, all of them perhaps contain some truth, and may be applicable to localities more or less extended. The burning of the forests, in a few cases doubtless, has changed timber into prairie land, and prevented the timber from invading small tracts of the prairies. But the sweeping, consuming autumnal prairie fires are not sufficient to account for the origin of our wide prairies, else prairies would be found scattered through all the timbered regions of the continent. Neither is atmospheric causes sufficient, for the observations of meteorologists show the annual precipitation of moisture in the form of rains, over our North-western prairies, quite as evenly and extensively as in the timbered regions of the eastern and northern parts of the continent. The chief causes of the treeless character of our prairies are undoubtedly found in the soil itself.

It is very true that trees, even those whose native habitats seem to be the damp alluvial soils of our river banks, will flourish and grow when planted upon the prairies; but the artificial process of planting, seems to fit the soil for their reception. Even vines, Indian corn, and many other sorts of vegetation, will flourish when thus artificially planted, but never would grow naturally and of their own accord upon the grass-bound prairie sod. The prairie soil is naturally adapted to the growth of prairie grasses; and the prairie grasses not only resist the growth of trees, but actually kill them out. By destroying the grasses and sods and cultivating the trees, they will grow vigorously. The prairie soil has certain antiseptic properties, and ulmic and other acids, which give it a sourness. The prairie grasses naturally flourish in such a soil. These properties in the soil, and these grasses, are all unfavorable to the growth of trees; and it is only when their influences are counteracted by cultivation or other local causes, that trees will grow in health and vigor. Cultivation does destroy this sourness in the soil; and I believe if all the cultivated prairies of the State were suffered to relapse into uncultivated wastes, instead of going back to their prairie condition, they would become eventually covered with brambles, thickets and growths of timber.

In this part of the State, along the Mississippi, Rock river, and other streams, much of the alluvial bottom subject to annual overflow, is covered with timber. There are, however, alluvial prairies along these streams, timberless, and for the most part sandy and coarse grained, and entirely different in composition and texture from the usual Illinois upland prairies.

The swamp lands of Whiteside, Lee and Carroll counties afford a fine illustration of Professor LESQUEREUX'S theory of the gradual transformation of swampy, boggy ponds, marshes and swales, into the black, spongy molds of our richest prairies. Aquatic vegetation, the gradual encroachment of the land into ponds, the slow drying of our wet lands, and the gradual filling up of the ponds by successive growths and decays of aquatic vegetation, is building up, rapidly, sour-soiled, treeless prairies. The processes are similar to those forming the peat beds. The results of the processes are curtailed and modified, and a peaty-soiled prairie is formed, instead of a bog or bed of peat.

But the high, rolling prairies of Carroll, Stephenson, Winnebago, and parts of Ogle and Whiteside counties, with, in many instances, but thin soils covering the coarser drift materials below, do not show so plainly the same sort of originating causes. They are interspersed with numerous small groves of timber. These grow along the alluvial mixed soil of the streams, and upon the ridges and patches thrown up and beat together by the waves and currents of the broad lake-like expanse of water, which covered this part of the State immediately subsequent to the glacial ice period. A few of these drift ridges, as in north-western Ogle county, are treeless, owing perhaps to fires, or other local causes.

Excessive humidity of these high, rolling, somewhat sandy prairies does not exist, and cannot satisfactorily account for their treeless character. Neither do they bear in their soils and subsoils the evidences of having once been swampy, marshy plains.

When the waters of the broad shallow fresh-water sea, once extending south and west of Lake Michigan, were slowly drained off, either by the breaking away of southern water barriers, or the slow upheaval of this whole region, parts of the bottom were undoubtedly left as broad marshes, swales, and bogs, which assumed in due course of time a peaty character; but other parts must have been left comparatively dry, and covered with the fine, impalpable sediment, constituting the basis of our present prairie soils. The swamp and peat lands of Lee, Whiteside and Carroll counties, afford fine examples of the former condition of things; the rolling, dryer, sandier prairies of Stephenson, Winnebago, and parts of Carroll and Ogle counties, afford just as fine illustrations of the latter condition of things, while Boone county exhibits very plainly, both.

The treeless nature of the marshes is very satisfactorily accounted for upon Professor LESQUEREUX's theory of the origin of the prairies. The treeless character of the high prairies must be accounted for by the nature of the soil itself; the natural tendency of an herbaceous, rather than of an arboreal vegetation, to gain and keep possession of the prairie soil, aided perhaps by fires and other local causes.

These views of mine may contain erroneous suggestions. I have had no special means to examine soils, or compare wide extents of prairie regions with each other. I arrive at my conclusions from simple observations of the prairies in this part of the State. I am satisfied that no one theory yet advanced, as to the origin and formation of the prairies, will account for all their phenomena, even in this limited portion of the State. Combined causes, operating with different degrees of force in different parts of the great prairie regions of the country—sometimes one cause predominating, sometimes another, and sometimes all together—are more in harmony, it seems to me, with the effects left for our observation.

Geological Formations.—Leaving the surface geology and turning our attention to the rocky strata beneath, we find the following formations, in descending order: The Niagara Limestone, Cincinnati Group, Galena Limestone, Blue Limestone, Buff Limestone, St. Peter's Sandstone, and the upper surface of the Calciferous Sandstone or Lower Magnesian Limestone. The Galena, Blue and Buff limestones are now classed as divisions of the Trenton Limestone. The Calciferous sandstone can hardly be named among the exposed and outcropping formations of North-western Illinois. It is the floor of Rock river, at a point where the St. Peter's sandstone outcrops in high bluffs along the shores of that stream. The local outcrops, superficial extent, characteristic fossils, and weathered appearances and exposures, are referred to in detail in the county reports, following. In this place I shall simply speak of their general characteristics and lithological appearances.

The Niagara Limestone.—This is a heavily-bedded, dolomitic, magnesian limestone, without any appearance of shaley or arenaceous beds, so far as I have noticed. In color, it ranges from a grayish-white to a brown or brownish-red, often finely speckled with minute dendritic-looking spots. In texture it is soft and fine-grained, like the Leclair limestone; tough, and of a horn-stone texture, like the Cordova lime-burning quarries; crumbling, coarse-grained and brecciated, like the quarries at Fulton City. And yet, with all this diversity, there is a similarity of structure and appearance, which makes it difficult to mistake the Niagara limestone for any of the other formations. From the north part of Carroll county to Port Byron, in Rock Island county, it caps the river bluffs, presenting that splendid castellated brown-red appearance so familiar to travelers on the Upper Mississippi river. It reaches a maximum thickness of one hundred and seventy-five or two hundred feet. It caps the mounds further north, and is called "the Mound limestone" by PERCIVAL and other of the earlier geologists. By DR. OWEN it was named "the Corraline and Pentamerus beds of the Upper Magnesian limestone," referring doubtless to the prevailing fossils. The *Pentamerus oblongus* is met with in great abundance in its upper beds, and its corals are so numerous, and finely preserved in the form of silicified casts, as to show us that the Niagara seas were the coral-paved seas of the Silurian age.

The Cincinnati Group.—Next in the descending order comes that group of clayey, unctious, fine-grained shales, formerly called the Hudson river shales by most of our Western geologists, but now more appropriately named by our own State geologist. The upper parts of the quarries show thin-bedded stratifications, but towards the bottoms of the quarries the strata become thick-bedded and solid. The thin shales are light-yellow, buff or green colored, soft, sometimes unctious to the feel, often giving a creamy color to the water, as it trickles down from the quarries, and crumbling and melting into clays when exposed to atmospheric influences. Some of the massive strata near the bottom of the formation are intensely hard and very blue.

The maximum thickness of this formation reaches perhaps a hundred feet. Above Savanna the outcrop is eighty feet in thickness, and at Bluffville a like thickness is exposed; and a well, thirty feet deep, near by, exposes to the bottom the shales and clays of this formation. In a few places the thin, cream-colored strata break into rhomboidal, diamond-shaped blocks of great regularity.

In a few localities the shales are almost black, and have so much carbon in their composition as to burn with a bright flame, giving out considerable heat, and resembling cannel coal. The flame resembles that of burning petroleum.

The fossils are mostly *Brachiopoda*, and exist in great abundance in some of the strata.

The stone, even the best of the hard blue, except in certain localities, is utterly unreliable as a building stone. It disintegrates and crumbles on exposure to atmospheric influences. On this account natural exposures are rare. In the high bluffs it often presents this appearance. The elevation is capped by the castellated Niagara; then comes a gentle grass-covered slope, succeeded by the rough outlined, underlying Galena limestone, with numerous springs flowing out near the base of the shales. This group is the upper division of the Lower Silurian, the Niagara being the lower division of the Upper Silurian.

The Galena Limestone.—This limestone, in lithological character and general appearance, closely resembles the Niagara. It presents the same bold, castellated appearance. The color is more uniform, being generally a light-creamy, warm color, with shades of ashy-yellow and dirty-white. The structure is more homogeneous and uniform, having generally a sort of crystaline or sub-crystaline appearance, except when the lower beds sometimes assume, in their passage into the underlying Blue, the characteristics of the latter. The upper beds sometimes have a crumbling sandy nature. The stone is massive, thick-bedded, solid, and becomes more enduring as it seasons. Its rich warm color and enduring nature make it a desirable material for heavy masonry.

The characteristic coral, the *Receptaculites sulcata*, "the sun-flower coral" or "lead fossil" of the miners, or "honey comb" of the common quarrymen, is known to almost every one.

This is the famous "lead bearing" limestone of the Galena lead basin. It is heavily developed over the whole lead region or lead basin of the North-west, a basin occupying an area, according to Professor Whitney, of about 4,000 square miles, and comprising portions of the States of Iowa, Wisconsin and Illinois. It reaches a maximum thickness of two hundred and fifty or three hundred feet. It is unnecessary at this time to speak of its mineral treasures in the shape of the rich deposits of lead ore found so abundantly in its caverns, crevices, and decayed and superincumbent clays, as in the first volume of these reports, this subject has already been discussed at some length. The Wisconsin and Iowa State Geological Reports both devote considerable space to the discussion of the causes of the deposit of lead, its modes of occurrence, and various other interesting thoughts and questions connected therewith.

A brief reference to our present knowledge upon this interesting subject of inquiry is all that will be attempted at the present time. If deemed necessary it will be more fully treated of in the report upon the geology of Jo Daviess county.

The origin of the lead and other minerals of this district is one of the vexed questions. At least four theories have been advanced and argued. These are as follows:

1. That the waters of the Silurian ocean held the minerals, or their salts, in solution. At the time of the deposition of the lead-bearing rocks, or at least before the deposition of the next overlying formation, the mineral matter was precipitated, in the form of sulphurets, in the crevices of the rocks.

2. The injection from below of the mineral matter in a melted state up through the crevices of the rocky mass. Many dykes, lodes, and true mineral veins, thrown up by volcanic or other igneous agency, doubtless owe their origin to this source; but it does not satisfactorily explain the origin of the Galena lead.

3. The theory of sublimation supposes the metal to have existed in hot vapor or steam. As this cooled, crystalization took place, and the mineral matter adhered to the sides of the fissures in the rocks, as frost crystalizes upon the window-panes. Craters of volcanoes, flues of furnaces and bloomaries also furnish familiar examples.

4. Another theory supposes that electro-chemical action caused a segregation of minerals into crystals in the soil, as geodes are formed.

The first of these theories is the most universally received, so far as the origin of lead and its associated minerals, in the Galena lead district, is concerned. The injection of melted matter from below into the fissures of the rocks accounts for the origin of many true mineral veins in a satisfactory manner; but in the lead region of the North-west the vast bodies of unfissured sandstones and other unmetallic formations below the lead-bearing rocks, make it almost impossible to trace the lead to this source. Professor WHITNEY, who is perhaps our best authority upon the geology of the lead region and the modes of occurrence of its mineral deposits, in his articles in the Iowa, Illinois, and Wisconsin Geological Reports, has well nigh settled the question in favor of the deposition of the ore in the crevices of the rocks by aqueous solution. He believes that the minerals were held in solution by the waters of the ocean, which deposited the lead-bearing rocks, and afterwards precipitated or deposited in the fissures, and that the development of life in the ocean produced chemical combinations in the sea water, which caused the precipitation of the sulphurets. In this way sulphurets alone were deposited, but the oxydized combinations of the sulphurets would form the few other accidental minerals found among these sulphurets.

The surface arrangement and systems of parallelism of the veins or lodes of productive mineral is a subject of interest in the mining district. East and west veins usually carry the mineral. North and south veins are unproductive, except in a few instances, where the general rule seems to be reversed. In connection with this, it may be well to remark that Dr. WHITE, the State Geologist of Iowa, has just announced that there is a well marked physical difference between the lead ore of the east and west, and north and south lodes; and also, that they have found in Iowa lead ore with small adhering crystals of native copper. Both these announcements are interesting discoveries.

Lead occurs in the form of float mineral, sheet mineral, and crystalized masses in openings and caverns. The float mineral is found in the red clay overlaying the lead-bearing strata, and results from the decomposition of the upper part of the lead-bearing rock, permitting the mineral to settle down into the clays thus formed. The sheet mineral exists in the form of thin veins in the solid rocks. The crystalized masses are found adhering to the tops and sides of caverns, or buried in the debris at their bottoms. The granular and fibrous structure is almost wanting in this lead region; the crystaline is the only structure generally noticed.

The causes of the fissures in these lead rocks is supposed to have been slow upheavals in the lead basin in past geological ages, and the dynamical agencies operating by reason of the contractions and expansions of whole geological formations.

The historic sketch of mining for lead, found in the published reports of the Illinois Geological Survey, although far more indefinite than we could desire, is perhaps as perfect as we can make it. Many facts and statistics have been lost; many items of interest were never preserved at all.

At the present time lead mining is in a tolerably flourishing condition. The amount of mineral raised is not so great as formerly, but the price is better.

Two practical conclusions seem to have been arrived at as a result of geological examinations in the lead region. First, that no system of deep mining will ever be generally adopted, simply because deep-buried bodies of mineral do not exist. Second, that a much better and cheaper way to prospect for lead, is to drift into and across the veins by adit levels, instead of sinking vertical shafts.

In speaking of the Galena limestone, I have thus been tempted to speak of the treasures lying away in its dark vaults. These vast bodies of metallic wealth have given an interest and a name to this interesting formation. The fortunes torn from its hidden fissures, and those yet to be torn from fissures more hidden still, will always, and in all time to come, dazzle the eye and mind, while the more modest merits—the rich, warm cream color, its enduring qualities as a building material, the good lime easily burned from it—are almost forgotten or overlooked.

The Blue Limestone.—Next succeeding in the descending order comes the Blue limestone, or Trenton limestone proper, of the earlier Western geologists. It is now regarded as the middle division of the Trenton group, the Galena above and the Buff below, both being now regarded as members of the Trenton. The upper strata are thin-bedded, and of an ashy-white or dirty buff color. The lower strata or layers are thicker bedded, and of an intense ultramarine blue, when first quarried, but afterwards bleach out to a paler or whiter blue. The whole of this division has a more or less conchoidal or glassy fracture, when broken; some of the bluer strata are exceeding conchoidal in their fracture, and have been characterized in the common speech, all over the lead mines, as the "glass rock." The Blue limestone reaches a thickness in this part of the State of from forty-five to sixty feet. It makes an excellent, and when properly dressed and mingled in its shades of color, a beautiful building material. The union school building in the town of Polo, a very handsome and tasteful structure, is built of this Blue limestone. An excellent article of common lime may be burned from it. All around the lead region, and where the streams cut through the Galena limestone, the Blue limestone appears.

It is one of the most fossiliferous deposits in this part of the State. A large species of *Orthoceras*, sometimes six or eight inches in diameter, and eight or ten feet long, is often found. A large shell, in a fossil state, related to the Nautilus, perhaps the *Lituites undatus* of Hall, is not uncommon. Corals, trilobites, and many species of shells, and some encrinites, are found in abundance, especially on Rock river, in the neighborhood of Dixon.

The Buff Limestone.—Between the Blue limestone and the St. Peter's, or upper sandstone, there exists a thin formation known as the Buff limestone, not recognized at all by the early Western geologists. The learned PERCIVAL mentions buff-colored strata or bands, noticed by him in his examinations of the Wisconsin lead regions. WHITNEY, in his geology of the lead regions of Wisconsin, gives it a thickness at Beloit of some forty-five feet, and at Winslow a thickness of some thirty feet. Following the section of WHITNEY at Beloit, I have called the similar section at Rockton the Buff limestone, and found its thickness to be some forty feet. But most of the sections and outcrops through this part of the State are thinner, averaging perhaps not over eighteen or twenty feet in thickness. This limestone is a heavy-bedded, dull colored rock, giving a dull, heavy thud or sound when struck by the hammer, as if the sound came from striking a lump of frozen earth. Some of the shaly divisions are very fossiliferous, being covered with shells and fragments of shells. In some quarries near Dixon, the strata are massive and solid, and give out almost a metallic ring, when struck by the hammer. In a few instances, as on Pine creek, where the Buff and St. Peter's sandstone meet, the line of junction between the two is hard to determine. Hand specimens obtained there seemed to be a mixture of both sandstone and limestone. At other quarries some greenish shales and clays intervened between the two rocks. Some of the layers are a compact, semi-crystaline magnesian limestone, one or two feet in thickness.

The upper portions of this formation or division are thin-bedded, and of a dull ashy-buff color. They break up into small fragments near the top, and greatly resemble some of the outcrops of the Blue limestone above.

The rock forms a good building material, but the superficial area underlaid by it is quite limited in this part of the State. It outcrops around the St. Peter's sandstone in narrow bands, and is recognized at Winslow, Rockton, Byron, and a few other places between the two rivers.

A few fine fossils, mostly a species of *Pleurotomaria*, were observed; but, as a general thing, the outcrops examined were almost devoid of fossils.

The St. Peter's Limestone.—This is the most interesting formation in the series of Illinois strata developed in this part of the State. Its only outcrop is along Rock river, from two or three miles above Oregon to about the same distance below Grand DeTour; and up the streams that fall into Rock river along this part of it, it also outcrops for a few miles; and a few disconnected fragments have been noticed projecting from a hill side in Chambers' grove, a few miles north of Polo. On Rock river the heaviest development, perhaps in the State, may be found. It reaches a thickness here of nearly two hundred feet. Fantastic shaped bluffs of white, brown and ferruginous stained sandstone, rise along the river banks, and display the coloring, shapes and castellated appearances of the icebergs in an arctic zone.

It is composed of pellucid, limpid, regular rounded grains of pure quartz, and is white almost as snow, when unstained by the oxyd of iron percolating through the mass as a watery solution. The slightest cohesion holds these grains together. Indeed, in some instances the mass is almost as friable as densely packed sand, and can be penetrated by a blow of the pick, or dug out with a sharp spade. The rock has a saccharoidal or sugary consistence, that would seem to indicate its rapid decay under rains and other atmospheric influences; yet, strange to say, these perpendicular, spire-capped hills resist these influences with great tenacity and success.

In some places in Lee county, a sort of calcareous cement is intermixed, making the rock so hard and semi-crystaline that it is used with success as a building stone. In the softer portions of the rock, there are many thin bands of a dark, hard, iron-looking consistence. These weather out in places, giving the appearance of pictured rocks. They are caused by thin crusts of the sandstone, having become impregnated with a strong solution of the oxyd of iron at various times, while the rock was in course of deposition. Many of these broken crusts resembles pieces of old cast-iron pots.

Some of them are beautifully marked with what I have been accustomed to consider wave or ripple marks. Prof. WHITNEY could find no evidences of the action of water, in his examinations of this rock further south. I have lately come to think, however, that these beautiful markings, instead of being ripple marks, may be wind marks. In examining some sand blows and dunes lately, I found them about their bases in sheltered positions, marked with the same wave-like etchings.

However that may be, it is evident that some unusual conditions must have existed when the St. Peter's sandstone was deposited. It underlies the whole lead basin, and outcrops heavily for a considerable distance around it, reaching on the south into Missouri; but nothing like it, so far as I know, is found any where else on the continent. Its origin is not well understood. The conditions of its deposition are involved in mystery.

This is the lowest rock in the series which outcrops in North-western Illinois. The floor of Rock river, I think, is made up of the top of the Calciferous sandstone, at several places between Oregon and Grand DeTour, but the formation outcrops no where at the surface, so far as I am informed.

The economical geology of this region will be found fully treated of in the detailed county reports, to which this chapter is but an introduction. The ores of lead and zinc, clays, sands, rock for lime, and for building purposes, peat, and many ores and minerals of scientific interest, abound, and are fully described in their appropriate places.

CHAPTER II.

JoDAVIESS COUNTY.

This large and important county is situated in the extreme north-west corner of the State. It is bounded on the north by the State of Wisconsin; on the east by Stephenson county, in the State of Illinois; on the south by Carroll county; and on the west by the Mississippi river. From north to south it extends twenty-one miles; from east to west, along the south line twenty miles, and along the north line thirty-six miles. It is divided into twenty-one political townships, not always corresponding in size or shape with government surveyed townships. These are named respectively, commencing and following the order in which the sections of a regular township are numbered, as follows: Courtland, Apple River, Scales' Mound, Council Hill, Vinegar Hill, Menomone, Dunleith, West Galena, East Galena, Guilford, Thompson, Rush, Nora, Ward's Grove, Stockton, Woodbine, Elizabeth, Rice, Hanover, Derinda, Pleasant Valley, and Berreman. These contain, in all, about five hundred and eighty-nine square miles or sections of land.

Physical Features and Configuration.

These are more diversified and interesting than are to be met with in any other county in this part of our State. The whole county is a part of the side of an extensive watershed, with a slope to the south-west. The county is excellently well watered. All the streams flow in nearly the same direction: from the north-east to the south-west. The principal of these streams, commencing at the eastern part of the county and going westward, are: Plum river, Camp creek, Rush creek, Apple river, Small-pox creek, Galena or Fever river, Sinsinnewa river, Little Menomone and Big Menomone rivers. Apple river and Fever river are considerable streams; the latter, in high stages of water in the Mississippi river, will float the largest steamers from that river to the city of Galena. Most of the others afford abundant mill sites for light mills and manufactories. At Hanover, on Apple river, there is quite a heavy power used, for the purpose of driving the machinery in an extensive

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woolen mill. Along the southwest part of the county there is some alluvial bottom land, made up of deep, black Mississippi mud bottoms and sand prairies; but these are not extensive. Some of the smaller streams have narrow and fertile alluvial bottoms. These are walled in, in most cases, with bluff ranges, more or less precipitous and rocky. The trend of the bluff line along the Mississippi river winds and bends with the general course of that stream. These bluffs are high, and gently rounded along the northwestern part of the county, but assume a more picturesque and castellated appearance as they enter Carroll county on the south.

It is almost impossible to give a correct description of the surface of JoDaviess county, without a minute reference to almost every township in it. In general terms, there are all varieties of surface found in the northern part of the State. Level prairie, rolling and undulating prairie and oak openings, uneven, hilly, rocky and bluffy timbered and farm land tracts, may all be found in almost any portion of the county. The eastern and north-eastern townships are generally prairie; soil rich, warm, and deep: some of it regular level Illinois prairie land; some of it, towards the center and south of the county, undulating, uneven, partly covered with scattering and scrubby timber. The southern tier of townships is uneven, sometimes hilly, sometimes rocky, with some prairie in Berreman, Pleasant Valley, and Hanover. The western and north-western townships are generally timbered, hilly, rocky, and even bluffy. The central townships are generally uneven and partly timbered.

The prairies of JoDaviess county are not excelled in fertility by any upland prairie in the State. The soil of the rough, uneven and hilly land, when cleared of its timber and underbrush, and laid open to the genial influences of good cultivation, is quick and fertile, being composed of a clayey, somewhat marly base. Numerous farms, some of them quite large, opened in the rough lands in every part of the county, attest the truth of this statement, and amply repay their owners for the labor of putting them under cultivation. Some of these reddish clayey soils might not look fertile to the husbandman used to the blacker prairie soils; but the large yield of cereal grains and grasses would soon convince him that their producing powers were almost equal to the vegetable molds and humus-charged soils of the leveler portions of the State. Indian corn, of course, is not so heavy a staple crop here as in other portions of the State farther south; still, good crops are raised with reasonable certainty.

Stock raising is also an important element of wealth in the county. The range is good, and sheltered situations for the winter are abundant. The citizens of the county, many of them, are largely engaged in this very remunerative business.

The agricultural resources, stock raising capabilities, and mineral wealth hidden away in the underlying rocks, are all leading elements of wealth in this county.

The county has an abundant supply of timber, for its own consumption, for many years to come. The oak family is largely represented among its trees; basswood, hickory, walnut, and, in short, all the trees, wild fruits and shrubs, catalogued for this part of the State, may be found in the bottom timber, barrens and groves.

Fruit growing and vine raising may both be carried on successfully. The hills about Galena, and in many other portions of the county, produce the hardy fruits and grapes in great abundance. The business has not been gone into extensively, but there is no reason why wine making might not be made to pay in favored localities. On the Galena hills I have seen grape vines purple with thick hanging clusters, while apple trees near by bent beneath their ripened fruit. The garden fruits attain also to great perfection.

A prominent feature in the landscape of portions of the county, is a number of natural mounds, rising to a considerable hight above the general surface.

Pilot Knob is the most conspicuous of these. It is about three miles south of the city of Galena, and about two miles from the Mississippi river. It is a conspicuous landmark to tourists and river men, passing up and down that stream. Towering above the surrounding high bluffs, it reaches an altitude of 429 feet above ordinary water mark in Fever river, according to barometrical measurements, made by WHITNEY.

There is a chain of some half dozen of these mounds, running north-east of Pilot Knob four or five miles, among them Waddel's and Jackson's Mounds, well-known local elevations. Around the city of Galena there are several mound-like elevations and ridges, the most conspicuous of which terminates in a group of castellated rocks, near the residence of a Mr. HALLET. These rocks overlook the city, and crooked valley of Fever river, for some distance.

Charles' Mound, near the north line of the county, is supposed to be the highest point of land in the State. Its ridge-like, rocky backbone is 295 feet above the Illinois Central Railroad track, at Scales' Mound station; 951 feet above low water in the Mississippi river, at Cairo; and 1226 feet above low tide in the Gulf of Mexico. These are the figures given by WHITNEY.

Scales' Mound, about a mile south of the last, is a well known locality. Around this latter, and within a radius of two or three miles, there are several other similar but smaller mounds.

East and south-east are Woods' Mounds, in the south part of Apple River township; Bean's Mound, near Apple river; Powers' Mound, in the north-west corner of Rush township; Paige's Mound, near the south line of Courtland township; Simmons' Mound, near the north-east corner of the township of Stockton; Benton's and Rice's Mounds, a little north and west of the latter; one or two mounds or mound-like elevations east of Elizabeth, whose names I did not ascertain; an elevated, mound-like plateau of several miles in extent, commencing about two miles north of the village of Elizabeth; and several other such plateaus in various parts of the county.

The geological structure of these mounds gives them the appearance of gently sloping hills, for a part of the distance up their sides, crowned by abrupt, fancifully weathered, castellated rocks, of a reddish-brown or whitish-yellow appearance. Some of these views, from a distance, have a great resemblance to old mural walls and baronial towers, and vividly recall to memory the wild architectural structures of the middle ages. Their geology is quite interesting, and will be more fully dwelt upon in a subsequent part of this report.

These same Niagara rocks outcrop in long mural escarpments along the Mississippi and Apple river bluffs, and along many of the smaller streams in those portions of the county where this geological formation is heavily developed. The ledges and exposures, and some of the abrupt outliers of the Galena rocks, also present the same picturesque, wild appearance. Some of them present scenes almost as attractive as any in Jackson county, about the Devil's Backbone and the Mississippi Bake Oven.

It will thus be seen that the topography and physical features of this county are well marked, and attractive in the extreme.

Surface Geology.

Alluvium.—The small water courses of the county have the usual narrow alluvial bottoms. In some places these spread out wide enough for small farms. Pleasant Valley, along the north branch of Plum river, extends from Morseville to the Carroll county line, a distance of some ten miles; it is from a quarter of a mile to almost a mile in width, and contains some of the very best farming lands in the county. These narrow alluvial bottoms are composed of a rich, brown, marly soil, made up in great part from the wash and detritus from the hills on either side. In but few places can there be noticed the black silt or mud or washed sand of river alluvium. The valleys are all ancient valleys of erosion, floored or built up by recent detritus from the hills, not transported to great distances, nor greatly mixed, and belonging to very recent Quaternary deposits.

The Mississippi river bottom, in the upper part of its course along this county, is very narrow—in fact that stream almost washes the rocky base of the bluffs for many miles. There is, however, a chain of sloughs opposite Galena, and along the mouths of Fever river and Small-pox creek, where there is a low alluvial bottom, timber grown, and made up of Mississippi mud and sand. This is the flood plain or flood bed of the stream, over which the annual overflows of high water extend. Farther down the river this bottom spreads out to several miles in extent. In the western part of the township of Hanover, bottom timber land, alluvial grass land, and a table land high and dry, and susceptible of cultivation—peopled by a considerable settlement about Huntsville landing—exhibit all the characteristics of the ordinary Mississippi alluvial bottoms. Farther down, in Carroll county, this bottom changes into the broad, well known sand prairie—an old, broad extended, glittering Mississippi sand bar.

Loess and Modified Drift.—The regular marly loess of the Mississippi bluffs, such as is found opposite Fulton City, at Warsaw, and at other localities further down, is not a marked feature along the western limits of JoDaviess county. Its bluffs are mostly composed of massive rocky formations. The bald bluffs, composed of whitish, partially stratified sands and clays, were not observed; but there are mound-like elevations, and masses of brown, marly, sandy clays along, among and overcapping some of these chains of bluffs, which undoubtedly owe their origin to the same agencies which deposited the loess of the bluffs, lower down the stream. These brown deposits are loess marls and clays, slightly modified by local conditions. Within the limits of the city of Galena, and at other points in Fever river valley, and forty or fifty feet above ordinary water level of Fever river, there are heavy outcrops of a well marked, distinctly stratified clayey deposit, which shows every characteristic of the most marked and well defined loess of the lower Mississippi bluffs. Thin seams of reddish clayey marls alternate regularly with thin seams of a whitish, tough, unctious-feeling clay. The seams are from one to four inches thick; the stratification is complete; the lithological character seems to be identical; the thickness is from ten to eighteen feet; and the extent into the hills indefinite, but probably limited. In the marly seams I found great quantities of a fluviatile shell, in a fair state of preservation. These shells are quite small, running from the size of a wheat grain to that of a large barley corn. I have several times, within a few years, noticed the same shell, or a closely allied species, strewn thick over the silt and mud after the floods of the Mississippi had subsided, and the flood bed had become overgrown with a dense growth of grass. Beneath the shadow of the grass the damp ground looked as if it had been thickly sown with large wheat kernels. Subsequent overflows no doubt imbedded these, and where antiseptic properties mingled with the silt, they will no doubt be preserved, and present an appearance exactly identical with those picked out of the outcrop near the Illinois Central Railroad depot in Galena. It will thus be seen, I think, that the evidences of the deposition of loess deposits in this county are incontestible.

In the Fever river valley, within the city of Galena, a mile or two above the city, and at several places between the city and its confluence with the Mississippi river, there are well defined river terraces of modified or river drift. These are about twenty feet above ordinary water mark in that stream. Similar traces were observed by Professor WORTHEN at the mouth, and up the valley of the Small-pox creek; and a broad, distinctly marked river terrace may be observed in the lower part of the Mississippi bottom, extending down into Carroll county.

Drift Proper.—The productive lead field has been written down as "a driftless region;" and to some extent this is true of that part of it within Jo Daviess county. But in attempting to account for this supposed absence of the drift in the lead region, eminent geologists have fallen into a controversy, or difference of opinion.

WHITNEY contends that when the lead region was uplifted from the Silurian seas, no subsequent submergence ever took place; and that all the changes which have since taken place on its surface, have been produced by agencies, such as we now see producing dynamical results upon dry land. When the broadly extended drift forces—whether broad creeping and grinding glaciers, or broad water currents, or icebergs and water acting together—moved the drift on its south-west course, according to this theory, the lead region rose as an island in the midst of the moving forces, and the drift stream was divided—thrown to the east and west—and united again after passing the obstruction. Such being the case, the lead basin, supposed then to have been elevated above the surrounding country, escaped the action of the drift forces. During all this time, more peaceful geological causes are supposed to have been at work over the uplifted island, whose action has produced all the geological changes supposed to have taken place. Atmospheric and chemical agencies disintegrated the hard Silurian rocks. The surface rocks changed slowly into the clays now overlying the bed rocks, except so far as rains and winds may have transported these clays and subjected them to a mixing process. This being true, the superficial deposits of the driftless lead region are substantially *in situ*, at the very places where they were formed by the decay of the parent rock.

PERCIVAL believed that the high water shed, extending from the mouth of the Wisconsin eastward, rose as a reef in the drift epoch waters, and turned the drift to the west, through Iowa, and to the east, round the lead region. This reef may have permitted a sheet of shallow water to flow over it, and submerge the lead basin. In this way the action of the drift forces would be greatly modified.

My own observations upon the drift phenomena in this county have not been altogether satisfactory. In the first place I do not think it a driftless region. In addition to the drift pebbles and copper nugget referred to, by Professor WORTHEN, as having been found at the California lead diggings, I have observed numbers of large boulders lying over the prairie land in the eastern and south-eastern portions of the county; and I am credibly informed, that, on the high upland some three miles north of Galena, many boulders of a sort of buhrstone, whose parent outcrop is far north in Wisconsin, are strewn over the ground. Many of the clay deposits covering the very lead veins themselves, do not differ materially from the buff and yellow clays treated, and recognized everywhere else in the north-west, as true drift clays. The river terraces, and stratified loess deposits, above spoken of; the lithological character of the clays just referred to; the few "nigger heads" and lost rocks found in several places in the county, show unmistakably, I think, that the drift forces, especially towards the close of the drift epoch, had much to do in cutting down, carrying away, and arranging the great rocky formations which once existed, but which have now disappeared over large portions of the county. Over more than half its area, perhaps, the whole thickness of the Niagara limestone and the Cincinnati shales have disappeared, except the mounds left standing as sentries, at long intervals; and the very Galena bed rocks below where they used to stand, have had their surfaces denuded, to a considerable extent, in the operation. To one standing upon one of these mounds, and looking over the valley-like expanses between them, with the eye of a geologist, the conviction, that he is standing upon the old Silurian level of the country, grows into a certainty. Eroding and denuding influences have removed from three hundred to three hundred and fifty feet of Magnesian limestone and shales. It is impossible to suppose that simple atmospheric or chemical causes, acting no matter how long, could produce such gigantic results. Many submergencies and upheavals may have taken place; the dynamical powers of heavy bodies of water and water currents, and other drift forces, must have acted long and powerfully in bringing them about.

While these things all appear to be true, it cannot be denied that the superficial deposits covering the bed rocks, are, in part, derived from their disintegration, by rains, frosts, and other atmospheric and chemical agencies. I have examined many clay banks through the lead mine region, which bore unmistakable evidences of this. Those peculiar red clays, characteristic of the lead region, if dug into, show, first, the clays and hard pan, without rocks of any description, but as the deposits are penetrated, rocks begin to appear in detached pieces, becoming more abundant at a greater depth, until the regular strata of the bed rocks are reached. Now, these pieces are unworn by atmospheric influences; they lie in horizontal beds, parallel to the strata below; and are evidently the harder portions of the mass, which resisted the influences that changed the rock bed into a clay bed. Nearly all the float mineral, or clay bed mineral now found, is, also, nothing but the ore which has settled down from the decayed rocks, in which it was once held in veins, and mineral-bearing lodes.

This is also true of the clays covering some of the Niagara, and Cincinnati outcrops or bed rocks, for they partake largely of the underlying rocks, from which they have probably been derived. I think a chemical analysis of these clays would show a great similarity or exact identity with the rocks under them.

Professor WHITNEY'S theory of atmospheric agencies, and no submergence of the lead basin since its upheaval from the Silurian ocean, explains well these unmixed clays, *in situ* apparently, at the very places where formed; but it does not explain the great erosion and denudation which has taken place through the productive part of the lead basin; and is utterly inconsistent with the terraces, loess and drift phenomena, plainly manifest in almost every part of this county. If we knew exactly what the drift forces were, and how they acted, we would probably have no difficulty in seeing what influences modified their force in the lead basin. That such a modification did take place in some way, there can be no doubt.

The blue plastic clays, which lie near the bottom of the drift in other parts of the State, are sparingly developed here, so far as I have been able to observe. The boulder drift, and coarse gravel drift, which lie near the top of the true drift, except the few loose boulders already noticed, are, also, substantially wanting in this region. The yellowish brown clays, red clays, and hard pan, are developed here to a considerable extent; but the average depth of the superficial deposits covering the rocks in Jo Daviess county, is a good deal less than in portions of the State farther east and south. The great denudation which took place here, seems to have been followed by transporting agencies, which bore away a large portion of the materials thus disengaged, to other regions.

The phenomena here observed are probably best explained by supposing two epochs, when causes somewhat different in their results were at work. The first was the epoch of erosion and denudation, accompanied by vast transporting agencies of some kind, probably flowing water or modified drift forces. During this epoch the Niagara limestone was worn down, and the Cincinnati shales suffered disintegration, and most of the detritus thus formed was removed. The second epoch was one in which the waters or modified drift forces had partially or wholly subsided; chemical and atmospheric agencies worked upon the comparatively naked rocks; and the lead basin clays settled down in the places where the underlying rocks had decayed. Such a condition of things would, I think, explain all the phenomena observed in the lead region of this county. How far it might apply to other portions of the north-west lead region, I am unable to state.

The Niagara Limestone.—All the mounds, mound-like ridges and plateaus mentioned in speaking of the topography of the county, are capped by massive irregularly-bedded dolomitic Niagara limestone, ranging in thickness from about fifty to one hundred and seventy-five feet. The castellated appearance of these outliers of this great formation, as they cap these mounds, has already been mentioned. Tapestried with lichens and mosses, of a dull brown or red color, with castellated and fantastic forms, these rocks at once attract the attention of the most careless observer. In addition to the mounds, they cover other portions of the county in the south and south-west; and their ledges and exposures all round the edges, along the bluffs, and where the streams have cut deep channels into their midst, show the same massive, ragged and picturesque appearance observable on the mounds; except that they resemble more, long, irregularly shaped reddish-brown mural escarpments or walls, carpeted with soft green mosses and feathery ferns.

The superficial area of the county, covered by these rocks, is about as follows, in a general and approximately correct boundary statement:

The high bluff range, about Pilot Knob, is capped by this rock. It commences a short distance north of the Knob; the Knob itself is a high pile of Niagara limestone, resting upon the Cincinnati shales; and the bluffs from thence to Small-pox creek continue to show it along their summits. From this latter stream to the Carroll county line, near the point where it crosses Apple river, the upper part of the bluffs are composed of the same rock, and some grand outcrops of almost beetling crags may be seen here. These outcrops extend back from the brow of the bluffs, and are the bed rock over all that high plateau between the Small-pox creek and Apple river, extending in a strip several miles in width to the north-east, to about the township line, between ranges two and three east. Still farther to the north-east, and separated from this large field by some narrow belts of galena rocks, about the head waters of Apple river, is a mound-like plateau or table, about four miles long and two and a half wide, and grouped round it are a number of the mounds heretofore named. As already observed, these are all Niagara limestone structures, built upon the underlying Cincinnati shales.

Terrapin Ridge, about two miles south of Elizabeth, is the northern projection of another high table land of exactly similar character, extending south and a little west, between Apple river and Rush creek, nearly or quite to the Carroll county line; but this table land does not approach close to either of these streams.

About two and one-half townships in the south-east corner of the county, are underlaid by this rock. This field extends from the east and south county lines to the Rush creek valley, on the west, and nearly to Morseville on the north. Plum river valley and Dutch Hollow, in this field, cut down to the galena, in places, and show the gentle talus-covered slopes and outcrops of the Cincinnati group at many places along their sides.

The probable extent of the county covered by this formation, is a little less than one-third. There are many places throughout this extent where the eroding streams have cut down through the Niagara, into the Cincinnati shales, and even reached the Galena limestone below both.

Such is the superficial area covered by this rock, stated approximately. Its lithological character has been so often written that it seems supurfluous to speak of it here. The rock is generally massive, irregularly bedded; tough; of a yellowish color on fresh fracture, but weathering to a reddish-brown. It is full of chert bands; and some of the Niagara hills are macadamized with a thick floor of finely broken, dendrite-speckled flints, which remain from the decay of the strata formerly enclosing them. These flint hills, or flint covered hills, are characteristic of the Niagara limestone formation. The maximum thickness of the Niagara limestone in this county, cannot be accurately stated. The denudation which has taken place on its top, and the difficulty of ascertaining the bottom, make it almost impossible to measure its thickness correctly. Its heaviest outcrop is probably along Small-pox creek, where it reaches a thickness of over two hundred feet. As developed in this county, it is exceedingly homogenous in character—the varieties observed at Racine, Le Clare and Cordova, being wanting. In chemical analysis, lithological character, and general appearance, it is very similar to the Galena limestone. If a difference can be detected, it is less sandy and crystaline, and tougher than the latter formation. Its type or characteristic fossils are also different.

These are chiefly *Pentamerus oblongus; Favosites favosa; Halysites catenularia; Astrocerium venustum;* and one or two species of *Stromatopora* formed corals. The *Pentamerus* are the traditional "petrified hickory nuts," so often spoken of by the miners and well diggers. Huge blocks of the stone, in places, are sticking full of them. On the silex sown hills, bushels of rough weather-stained specimens of the *Favosites* can be collected. These old Niagara seas swarmed with the coral builders; and many of the Niagara beds of rock were little else than coral reefs.

The Cincinnati Group.—The green and blue shales and limestones of the Cincinnati group underlie the Niagara limestone wherever the latter is developed in the county. There are not many natural outcrops of these shales, and they never stand out in ledges or rocky exposures, unless where quarries are opened into the covered rocks. Even where quarries are opened into this formation, and then abandoned for a few years, the rapid disintegration soon covers up the rocks with a gently sloping talus.

The parts of the county underlaid by this formation can be told at a glance. All around the mounds and mound-like elevations; all around the outer boundary lines of the Niagara formation, up either side of all the valleys of erosion which have cut through it, the gentle slopes extending from the general level of the country up to the base of the bold Niagara exposures, are underlaid by rocks and shales of the Cincinnati group. These slopes may be represented by a narrow band two or three hundred yards more or less in width, encompassing all the Niagara fields and outliers in the county, and running up either side of all the valleys that are cut through it. When this is said, the superficial area underlaid by the Cincinnati group is as well indicated as it could be by many pages of description. One or two localities, however, deserve a passing notice.

At the northern terminus of Terrapin Ridge, near Elizabeth, the milky looking clays and shales are washed and furrowed out by the rains, exposing many fine specimens of the hemispherical-shaped coral *Chætetes petropolitanus*. I have found dozens of good specimens of this coral in the clay-washed road at this locality.

East of Scales' Mound the track of the Illinois Central Railroad is laid for several miles almost upon the top of the Galena limestone. Several rather heavy cuts in that locality show good exposures of the overlying Cincinnati shales. These beds contain in certain layers a very great abundance of minute fossils, principally a small *Nucula*.

The general character of this group in Jo Daviess and Carroll counties is almost identical. The upper layers are thin-bedded argillaceous and silicious shales, of a light buff or creamy color. Where thick-bedded enough to quarry, the stones have a kiln-dried dusty appearance. Lower down, the shales become blue or greenish in color, sometimes separated by thin bands of green, marly clay; still lower, some massive strata of a deep ultra-marine blue color may be found, exceedingly hard, and giving out a clear ringing sound when struck with a steel hammer;

below these there is found in some localities a black carbonaceous shale, so highly charged with carbon as to burn with a bright flame as though impregnated with oil, and the bottom of the deposit is made up of thinner strata of alternating yellow, blue, and green shales and clays. Wherever the rain cuts through the soil into these shales, or the little streams wash them, the wet clays have a greasy look, and the trickling waters a creamy and greenish color. There are no gradual beds of passage into the overlying Niagara or the underlying Galena limestones; but the formation preserves well its distinctive characteristics. The beginnings of its foundation stones and its cap rocks are always easily recognized.

The thickness of the deposit cannot be accurately stated. A true section, as developed in the Mississippi river bluffs, from Bluffville, in Carroll county, to the mouth of Fever river, would run from eighty to one hundred and twenty feet. In the interior of this county it nowhere perhaps reaches to one hundred feet, and in some places it is only from forty to sixty feet.

The deposit is full of well preserved fossils. The *Orthoceratite* beds in Dubuque county, Iowa, have long been famous for the number of well preserved *Orthoceratites* with which they are crowded.

The *Chætetes petropolitanus* is a characteristic fossil, and is found in great abundance at Elizabeth, and in the washes and ravines at other places. Fragments of a branching coral, and the small bud-like heads of an *encrinite*, are generally found in the same localities. In a few places I observed immense numbers of the fragments of *Isotelus gigas;* also several species of *Orthis*, among them *Orthis lynx;* associated with *Ambonychia radiata*, *Strophomena alternata*, fragments of two or three species of *Orthocera*, and one or two of the new fossils described in the Third Volume of the Illinois Geological Reports, *Strophomena unicostata* and *Tentaculites sterlingensis*, were also observed.

The Galena Limestone.—This is the great bed-rock of the county. From Dunleith to about the mouth of Small-pox creek it forms the rocky bluffs on the Mississippi river. All the north-western, northern, and north-eastern part of the county, except a few of the mounds heretofore named, is underlaid by it. The eastern part of the county, extending a short distance south of Morseville, is also underlaid by the same rock. All the larger streams in the county, including Sinsinnewa, Fever, and Apple rivers, Rush, Small-pox and Plum creeks, with their principal tributaries, flow along the surface or cut into this formation. It immediately underlies the surface deposits of something like two-thirds of the county.

The maximum thickness of the Galena rocks in this county is not known. It is probably not far from three hundred and fifty feet. At

Elizabeth, shafts are sunk one hundred and fifty feet deep, and what is known as the flint strata among miners, was not reached. At the places of these shafts the Galena had been considerably denuded. The flinty strata generally is characteristic of the middle of the formation. It may be, however, that the estimate from this basis is too great. No outcrop observed was over about two hundred feet thick.

Its lithological and stratigraphical character is too well known, and has been too often given in these reports, to require an extended notice here, as all into whose hands this report will be likely to fall will probably have access to those descriptions. The rock is a thick-bedded, subcrystaline, compact, cream or chrome colored dolomitic or magnesian limestone. It weathers out into forms almost as fantastic and picturesque as the Niagara above it. Along the streams its weathered out ledges present the same castellated and mural appearances; and some of its outliers rise into towers and chimneyed shapes of the most striking outlines. At Dubuque, or rather opposite Dubuque, at Dunleith, a curving tunnel has been cut through the solid rocky bluff, some eight hundred feet in length, for the purpose of permitting railroad trains to pass over the new bridge across the Mississippi river at this locality. This tunnel is about twenty-five feet above the Trenton or Blue limestone. The base of the Galena here is not far from the water level of the river. The rock removed from the tunnel is not so yellow in color or granular in structure as that obtained from the upper parts of the deposit. It shows the beginning of the beds of passage into the underlying blue limestone of the Trenton. The rock removed from the shafts and mines at Morseville and Elizabeth has a granular appearance, and a color peculiar and difficult to describe, a color between a cream-yellow and a cerulean-blue, if such a color can be imagined. There is also, mingled with this, a greenish rock, corresponding with the rock found at the green rock openings about Mineral Point.

Other peculiarities of this limestone will be noticed when I come to speak of the lead deposits under the head of economical geology.

Fossils are not so numerous in the Galena limestone of this county as in that of Carroll, Stephenson, or Winnebago. At Morseville, among the stones and debris thrown out from the lead diggings, I obtained several fine specimens of *Bellerophon*, the only fossil there observed. *Illaenus crassicauda* and *I. taurus* have both been found at Galena; a large species of *Cypricardites* is also frequently found, especially in the quarries in Carroll county. *Murchisonia bellicincta* and *Receptaculites Oweni*, two of the most characteristic Galena fossils, are found less frequently here than in any other portion of the formation in neighboring counties. A section of the largest *Orthocera* ever discovered in the lead region, perhaps, was found in the Galena limestone at Morseville, some two years ago, by some of the miners. It was eighteen or twenty inches long; a siphuncle nearly three inches, in diameter projected about four inches at one end; the septa, somewhat loose, looked somewhat like a ribbed human body with a projecting neck. Of course, those who saw it supposed that a petrified human trunk and neck had been discovered.

Trenton Limestone.—This limestone is only met with in two localities in the county. At Dunleith, and a little above it, there is a low outcrop along the banks of the Mississippi river. It is here a light bluish-gray rock, regularly and rather thinly bedded, with shaly partings, showing many of its characteristic fossils. These layers are near the top of the formation, and have some of the characteristics of the superincumbent Galena. They, in fact, begin to partake of the nature of beds of passage into that rock.

At Dubuque splendid specimens of *Graptolites* have been found in the Trenton; also very finely preserved eyes of *Trilobites.*

Other exposures of this limestone may be seen along the north branch of Fever river, commencing about three miles north-east of Galena, and continuing until the Wisconsin line is reached. The outcrop attains a thickness of about twenty-six feet at its heaviest exposure, at Tuttle's mill. It is made up of thin-bedded limestone, a rather thick-bedded strata of glass rock, and grayish heavier bedded limestones. Near the forks of Fever river, a cut of the Illinois Central Railroad shows a similar, but thinner section. Many of the well known fossils of this formation are said to have been found at these outcrops. But the conditions were not favorable for obtaining fossils at the time I was there.

This is the lowest formation anywhere outcropping in the county, or that can be regarded as belonging to a section of JoDaviess county rocks. We are now prepared to give that section, naming the approximate average thickness of the formations:

Section of JoDaviess County Rocks.

Quaternary Deposits. Alluvium, loess, river terraces, clays, sands and hard-pan	20 to 75 feet.
Niagara Limestone. Heavy-bedded reddish-brown dolomitic limestone, weathering into cliffs and castellated exposures, similar in lithological character and appearance to the Galena limestone	40 to 200 "
Cincinnati Group. Green and blue and buff colored shales; thin-bedded gray limestone, and hard, thick-bedded glassy rock	42 to 80 "
Galena Limestone. Heavy-bedded, cream-yellow dolomitic limestone, the lead rock of the North-west; somewhat granular, and crystaline, and showing beds of passage into Trenton below	100 to 275 "
Blue Limestone. Thin-bedded gray limestone and shales and glass rock of miners	10 to 26 "

Economical Geology.

Building Stone.—There is the greatest abundance of good building stone in this county, so distributed as to make it of easy access to all its citizens. All the formations are quarried. In Pleasant Valley a number of good quarries are opened in the Cincinnati group of rocks. These quarries are in the brows of the hills, on either side. The stone obtained is sufficiently thick-bedded and compact to make a good building stone. It has a dry, dusty, kiln-dried appearance. Several farm houses are built of this material in the valley. So far it seems to answer well for farm uses, without exhibiting a tendency to disintegrate. The best of it would, I think, be unsafe for massive and long enduring masonry, but for light masonry it seems to answer well; and its convenience of access, and the ease with which it can be quarried, will always cause its outcrops to be kept open and worked. The abundance of better building material in most parts of the county doubtless prevents its extensive use in other places, where it could be easily obtained.

The Blue limestone outcrops, along the north branch of Fever river, afford some good building stone. This is a light-gray limestone, rather thin-bedded, and of enduring properties. The outcrop at Dunleith also splits into a conveniently handled stone, and is used extensively for economical purposes.

The massive ledges, exposures, and natural outcrops of the Niagara and Galena limestone along nearly all the streams, in the brows of all the bluffs and hills, and in all those parts of the county where these heavy deposits are the bed rocks, furnish an inexhaustible supply of a coarse, enduring, valuable stone, suitable for all sorts of heavy masonry, such as bridge piers and abutments, foundations, cellar walls, and even public buildings and private residences. They require considerable dressing for these latter purposes, but when dressed into good shape, their rich, warm, brown and cream colors, and the fact that they season into almost the hardness of a granite, and have an enduring, solid, substantial appearance, makes them prominent among the materials of economical value in the county.

Lime.—We know not to what extent lime is burned in the county. The abundance of timber and the abundance of good magnesian limestone, afford all the facilities for manufacturing large quantities of a good, coarse, strong lime.

Clays and Sand.—The clays associated with the Cincinnati shales are sufficiently pure to furnish a potters' clay, good for the manufacture of common crockery ware. At Elizabeth I noticed several outcrops of this potters' clay in some of the streets and lots of the village. Four or five miles south of Elizabeth, on the Mount Carroll and Galena road, the Jenkins' pottery is located. This establishment has been in operation for quite a number of years, and has built up quite a remunerative business. The clay is obtained near by. It is not altogether pure and free from foreign substances; but these difficulties seem to be mostly overcome by the processes through which it is put in manufacturing. The result is, a ware largely used in this part of the State, as the Jenkins' pottery wagons are well known in all the neighboring towns, villages and cities.

Common yellow and red clays, for ordinary brick, exist everywhere in the greatest abundance. Sand, suitable for building purposes, is not so universally distributed, neither is it so scarce as to be a matter of serious inconvenience.

The Associate Minerals.—Associated with the galena, and deserving a passing notice before that important mineral deposit is referred to, are several other mineral substances well known in the lead region. The most important of these is the sulphuret of zinc, blende or "black jack" of the miners. This is a useful ore of zinc, but is quite difficult to reduce. In the lead region it is not considered of economical value. The carbonate of zinc, smithsonite or "dry bone" of the miners, is considered a more valuable mineral. A furnace for its reduction has been in operation for some years at LaSalle, and has proved a financial success. Iron pyrites also occurs in connection with these minerals, in considerable abundance. At the celebrated Marsdens' lead, all these associate minerals may be seen associated with each other and with the galena, with the Galena limestone, and with spar and other substances. This mine has afforded the best cabinet specimens of these minerals in combination to be found anywhere in the lead regions. Brown hematite, and several other mineral substances, occur in occasional small quantities, but they are not of interest, in an economical point of view. None of these associate minerals have become articles of commerce, except, perhaps, the carbonate of zinc; and it is doubtful if even that exists in sufficient quantities to make it an article of value in the economical resources of this county.

Galena or Lead Ore.—The great mineral interest of the county, as every one knows, is lead. Indeed, it is second to no mineral interest in the State, except that of coal. The leading ore of this metal has given its name to the great and important rocky formation in which it is chiefly found in this part of the country, to an important city in the midst of its heaviest deposits, and to the township in which that city is located.

The scope of this county report does not embrace a very extended essay upon the mining or metallurgy of lead, or a topographical survey or description of the crevices, leads, lodes and diggings, nor a scientific discussion of the modes of occurrence and phenomena observed in its workings. It is rather the province of this report to present the geological formations of the county, and some general remarks upon the extent of its mineral and other resources. The "Lead Region" has been closely examined and ably written upon by Professor J. D. WHITNEY, for the three States of Illinois, Wisconsin and Iowa. It will be unnecessary to repeat here what he has presented so well in the first volume of the Reports of the Illinois Geological Survey. That volume will be as accessible to the common reader as this, and to that volume we refer the reader for surveys and descriptions of the crevices and leads, and a detailed account of the different diggings, their positions, peculiarities of form, extent of working, amount of ore produced, and facts collected in regard to them. It would be useless to write these things over again; and if it was not, my knowledge of the lead regions and opportunities of investigating its facts and phenomena have been far too limited to undertake the task. A brief *resume* of some of the facts and history of lead and the lead region may not however be out of place.

Galena, or the sulphuret of lead, called in the common speech of the lead region "mineral," when pure, is composed of 86.55 pure lead and 13.45 sulphur. It crystalizes in the form of the cube and its secondaries, has a perfect and easily obtained cleavage, and a bright, silvery, metalic luster on fresh fracture. The lead ore obtained in this county is nearly pure galena. It sometimes contains faint traces of silver.

The discovery of this lead was made in an early period. There can be no doubt, I think, that the early voyageur, trader and explorer, LE SUEUR, on the 25th day of August, A. D. 1700, discovered and described Fever river under the name of "The River of the Mines." From this, and the description of a mine found, in his journal, he is generally considered the discoverer of the Galena lead mines. Subsequently to this, and prior to the working of these mines by white men, they were undoubtedly worked to some extent by the Indians, in their rude way. These primitive miners—or rather their squaws, perhaps—rudely drifted into the hills, and loosened the mineral by building fires against the rocks and then throwing water on them, as ancient mining was once carried on in the copper mines of the Lake Superior region. Some eighty years after this the wife of an Indian chief, *Peosta* by name, struck a lead just below the city of Dubuque, which was worked by JULIEN DUBUQUE, under permission from the Indian tribes. In 1819 the present city of Galena was first settled, by a man named BOUTHILLIER. In 1820 several others joined him, and a trading house was opened by JESSE W. SHULL and Dr. MUIR. The adjoining country was a wilderness. By this time the Galena mines had begun to attract attention.

In 1823 emigration was pouring in lively. The Government had reserved all its mineral lands in this part of the country. In this same year Lieutenant THOMAS was sent here by the United States to look after these mineral lands. He granted leases, collected rents, and looked after the mines generally. In 1827 population had so increased that a village was laid off on the present site of Galena, and named from the mineral found on its site and around it. There is a dispute as to whether Lieutenant THOMAS or Dr. MUIR named the village. The authorities differ on this proposition. In this year permits were given by the government to occupy and improve lots. The possessors of the permits were liable to surrender them to the government upon thirty days' notice. These permits were poor titles; but the people had no better up to 1836, at which time Congress confirmed the titles of those in actual possession of the town of Galena, laid off into lots by act of Congress, in 1829. Previous to 1827 the leasing policy of the Government had substantially failed, and the miners were working wherever they could obtain mineral, without regard to the claims or ownership of the Government.

The mineral lands, shortly after the first settlement of Galena, had been turned over to the War Department, and the leasing or permit system was continued up to 1846, every year running the Government into debt. In this year a law was passed by Congress, throwing the mineral lands into market, and in 1847 the mineral lands in JoDaviess county were brought into market and sold to actual purchasers. During all this time other settlements had sprung up, the most important of which was the trading post called "The Portage," just below the present site of the city of Galena. The Indians swarmed over the lead region at the time of its first settlement. Their squaws discovered many mines, worked them to some extent, and traded the mineral to the white settlers. Among these early mines was the "Buck Lead," near the present site of Galena, discovered about the time of its first settlement.

From 1827 the mines rapidly grew in importance and multiplied in numbers. From 1840 to 1850 the greatest degree of prosperity was reached in the mines, about midway between those years being the very acme of mining prosperity. Galena became the mining metropolis of the North-west. Thousands of rough miners swarmed through her streets. All sorts of moving vehicles were seen in her thoroughfares, and every language was spoken, every costume worn. The miner generally spent all he made, was poor, and held his own remarkable well. And that reckless spirit, bred of all uncertain pursuits, was abundantly manifested among the miners who assembled in the lead region. Card playing and whisky drinking, quarreling, and that rough desperate life developed among adventurers of all classes gathered about Galena, was characteristic of those as of all other mines. But in the midst of it all, the city of

Galena grew to unexampled prosperity and wealth, and for hundreds of miles round was the center of commerce and trade for the whole country. Treasures came up out of the ground, flowed into the city, and there remained and built it up. The discovery of the California gold mines swept from the lead mines all that floating part of its population ready for a new excitement, and also much that was of a more permanent nature. The lead mining interest rapidly decreased in importance, until the financial troubles of 1857 drove many back to mining as a matter of necessity. At the present time considerable attention is paid to mining, and it is probably a fact that mining labor generally is better and more uniformly paid now than at any other period in the history of the mines. With all the vast amounts of mineral found, it is also a fact that but a very small proportion of the ground has been proved.

We cannot arrive at even an approximately accurate amount of the mineral mined in JoDaviess county. According to Mr. WHITNEY, the amount of lead received at Chicago and St. Louis, as per records of the Chamber of Commerce and Board of Trade, from 1853 to 1859, including both years, was about 181,000,000 pounds. This was from all sources. Of this amount he thinks about one-sixth was derived from mines in Illinois, almost exclusively in this county. This would give about 30,000,000 for this county for that period, which period was the least prosperous time for mining known to exist for many years. From the detailed descriptions given of particular leads and ranges, by the same gentleman, in the first volume of the geological report of Illinois, we find that he gives the produce of certain enumerated mines up to that time at about 64,000,000 pounds. The Apple river diggings are supposed to have produced from one-half to one million of pounds. The Elizabeth group of mines are stated, by HENRY GREEN, Esq., an old miner and smelter, to have produced from 60,000,000 to 75,000,000 pounds. Mr. GREEN is probably below the amount actually produced. The Vinegar Hill diggings, being a group of about forty lodes or mines, are supposed to have produced 100,000,000 pounds. This statement is made upon the authority of Mr. HOUGHTON'S pamphlet upon the Marsden lead. From the same authority we learn that the maximum production of the JoDaviess county mines, in 1846, was 56,000,000 pounds. The Council Hill mines are supposed, by D. WILMOT SCOTT, Esq., to have produced 19,000,000 pounds. The Morseville mines are stated to have produced from one-quarter to one-half million pounds. Captain BEEBE stated a few years ago that five furnaces were in operation in the county, smelting annually 8,750,000 pounds of pure lead, some of which was obtained outside of the county. The Marsden lead is said to have produced 3,000,000 pounds of mineral. A writer in *Harper*, for May, 1866, states that the amount of lead shipped from the Galena mines from 1821 to 1858 was 820,622,839 pounds, and the value of lead shipped from 1821 to 1865 was not less than $40,000,000. The New California diggings, a few miles south of the Marsden lead, has been yielding a great deal of mineral since their discovery, but I have no means of knowing the amount. These are but a few of the figures and statistics. Hundreds of small ranges, mines and leads have not been mentioned. Multitudes of surface diggings have been carried on, for the purpose of obtaining "float mineral," none of which were very extensive, but the sum total of which aggregated a great deal of lead.

From these figures—and they are imperfect enough—it can be seen that the mineral interest of this county in the past has been a matter of great magnitude. Together with Shullsburgh, Mineral Point and Dubuque, this North-western lead basin has been, and yet is, one of the greatest mining localities in the world.

The superficial area of the county underlaid by productive lead deposits, so far as known at the present time, is limited, embracing but a small fraction of the area of the Galena limestone. The lodes or ranges are principally located in groups. The diggings, mines or workings are in patches; but seem to have many features in common. The most southern productive mines in the county are on the great east and west range of mineral passing through and just north of Elizabeth. This mineral range commences at the mouth of Yellow creek, a few miles south-east of Freeport, in Stephenson county, where an old shaft exists, which used to be heavily worked a good many years ago. The next group of mines on this range to the west is at Morseville, in the south-eastern part of Jo Daviess county. Here lead has been mined more or less for many years. Several men have accumulated a competence, especially the former proprietors of the old Price lead. The workings are shallow, and the water strong at twenty-five or thirty feet deep. Prospect holes cover the hill sides, and piles of red clay indicate them along many of the ravines. The following ranges or leads are worked at the present time: the Blair range, about one fourth of a mile west of the village, near the road; the Company lead, a little south of the village; Clevinger & Mitchell's range, just south of Mr. Morse's house; Mumma & Livingston's lead, west of the village, which is the old Price mine; and a lead called the Lyons lead. No one seems to know the amount of mineral produced from these mines. One gentleman informed me that it had been about one half million of pounds. At the present time one or two of the leads are furnishing a considerable quantity of excellent looking heavy lead; some of it is in large cubes. The stone thrown out from these leads has a granular, greenish, blue look, resembling what is called the green openings of the Wisconsin lead bearing rocks, but probably higher up in the series.

The next heavy mines westward, on this same mineral range, is the group at Elizabeth and Weston. About 2,500 acres here are prospected over and mined in. It is an irregularly shaped tract of land, about six miles long from east to west. The village of Elizabeth is located upon its southern edge, a little east of its center.

The most extensive lead now worked is the Wishon diggings, discovered some two years ago in a cultivated field, about a mile north of the village. During the last year this mine has turned out nearly forty thousand dollars worth of mineral. The mine is now worked by a company, under the superintendence of Dr. Little, of Elizabeth. A strong steam engine runs night and day, and gangs of hands relieve each other every eight hours. The workings have reached thirty-five feet below the water level. The shaft is about one hundred and fifty feet deep, and still going deeper. The mineral is found principally in vertical openings, in some places several feet wide, and full of clay, loose stones, and chunk mineral. The company are driving their drifts in several directions, and at several different levels. The object now seems to be to develop the mine, and not simply to obtain mineral. Many heavy deposits are passed and left for future working. The prospect of a rich future yield in this mine is very encouraging. I spent about two hours in the bowels of the earth here, and then explored but a few of the horizontal drifts. The old Haggerty diggings, the Van Meter range, Stone's field and Kilpatrick's field, have all furnished abundance of mineral, and some of them have been worked for 35 years. The oblong track of ground above mentioned has been prospected over and mined in extensively. Deep crooked holes, red clay and stone piles, and timbered shafts might be counted by the score. It would be impossible to give the names of all these.

The Elizabeth mines were discovered at a very early day, and worked to some extent. In 1846 more than 800 miners are stated to have been engaged in mining about Elizabeth and Weston. At this time one-ninth of all the mineral raised in the lead region is supposed to have been obtained here. Elizabeth and Weston were both swarming, active towns. Lead mining, in its glory, was actively engaging all classes of citizens, and the highest financial prosperity was enjoyed by all who depended upon the trade of mining and the products of the mines. The working out of some of the heaviest superficial deposits, and the discovery of the California gold mines, caused mining to rapidly decline. These mines soon, therefore, fell into disuse and neglect; but they are again assuming something of their former importance. At the present time labor in these mines is better paid than at any other period since their discovery. We mean by this that the general mining labor of all the mines, taken together, will pay a greater average remuneration than in former days, when a few made fortunes and the many only ordinary mining wages.

There is from twenty to thirty five feet of the "flint rock" above the water level. The flint, on the higher levels, is from 130 to 150 feet below the surface. The crevices gradually close before reaching the flint rock. The easily worked perpendicular crevices above the flint strata were first worked out, and then the mine was generally abandoned. Another observation worthy of notice is the local elevations and dips in this group of lead mines. The flint strata outcrop at the side of the Galena road in a ravine about two miles north-west of Elizabeth. This outcrop is a few feet above the water level of the brook near by. At Wishou's shaft, a short distance east of the outcrop, and near the top of the hill, the miners are working thirty-five feet below the water level of the mines, and still the flint is not reached. The water level in the mines rises slowly as the hill is penetrated; but this rising of the level could make but a few inches or feet difference at most; while the fact seems to be that there is more than forty feet difference between the bottom of the shaft and the flint outcrop on the road, and no flint is yet reached in the shaft. In other localities the same thing has been noticed. In prospecting for deep mining in this region, this fact may aid in coming to a correct conclusion as to the probable location of lead deposits.

Leaving the Elizabeth lead fields, the next heavy mines are found a few miles west, on the east and west slopes of the bluff range, bordering the Mississippi river. These are the New California mines, discovered accidentally only a few years ago, by a fisherman, who resided in a wild glen on the Mississippi river. At this point the rocky bluffs rise abruptly. The ranges are found by drifting into them a little above water level, going in where a crevice is noticed rising vertically through the rocks. The mineral found is heavy mineral, existing in large cubes or cogs in some instances. It resembles the large bodies of mineral found in the Marsden lead. On the east slope of the bluff range, where the hills fall away gradually to the level of the interior, several lodes are struck by sinking shafts down to the ranges. The following ranges have been struck in these mines, and perhaps a few others, the names of which I did not learn: Wise range, McKenda & Graham, Davis & Brownell, Bernard & Co., Lester, Sanders & Hony, Felt & Clymo, Wakefield & Co., Marble & Young, Dye & Co., Samuel Taylor. Other valuable ranges will doubtless be discovered, when all the crevices are examined.

West of the Mississippi river, in the Iowa bluffs, the same great mineral east and west range has been found. We have thus followed it almost entirely across the lead basin, and shall now leave it in the Iowa bluffs.

Five or six miles north of the New California diggings, the celebrated Marsden lead may be found. The discovery and history of this great mine was truly wonderful. Some light float mineral had been found in shallow diggings. Thirteen or fourteen years ago, the proprietor of the rough farm, which had been purchased by him for stock and dairy purposes, had occasion to drive a stake into a spring, and in so doing heavy mineral was struck. Mr. Stephen Marsden was then the owner of the farm. By following up the discovery, he soon found himself the possessor of a fortune. A succession of openings in the rock, each deeper than the other, were found to be filled with strong mineral. These openings have been followed to the depth of about 95 feet, and I am informed that nearly 7,000,000 pounds of excellent mineral have already been taken out. Only about one acre of ground has been worked over in obtaining all this mineral; and the prospects of other heavy bodies of lead being found, both below the present level worked, and on other parts of this farm, are said to be very promising. This farm and mine has recently been sold by Mr. Marsden to an eastern gentleman, and a company organized to work this mine on the most approved and extensive plan.

This range is celebrated not only for the amount, but for the variety and beauty of its mineral deposits. Large cubes and diamond-shaped masses of lead ore have been found here, perfectly coated with a beautiful covering of iron pyrites. Galena, black-jack, spar, and iron pyrites are found in wonderful combinations, furnishing the finest cabinet specimens found any where in the lead region.

The Marsden lead, the New California diggings, the Ambruster & Co. lode, recently discovered, and most of the mineral found along the western limits of the lead field in this county, have certain resemblances, both in the character of the lead ore and its associated minerals, not observed in the mines in the eastern part of the county.

The next important group of ranges to be noticed, is within and immediately around the city of Galena. The following are the names by which some of these ranges are known. There are many others whose local designations are not now accessible. Some of these are not now worked. They are mostly comparatively shallow diggings: Buck, Doe, Harris Leads, Kringle, Gaffner, Hog Range, Tomlin & Burrichter, Frysinger, Crombacker, Tomlin, Evans & Adams, A. C. Davis, Ambruster & Co., Ottawa Diggings, Drum, Rare & Co., Bennenger & Co., Graves, Comstock & Rosemeyer, Wallon & Quick, Sanders & Co., Muldore, Bolton, Stephen Marsden, Allenrath, Eagan, J. E. Comstock, P. Smith & Co., Hostetter & Co., Duer & Co., Allendorf & Co., Tom Evans, Britton & Wilkins, Cady Range, Roberts Range, Wm. Richards, Wilcox & Co.

In addition to the above named ranges, Mr. WHITNEY, in the first volume of the Geological Survey of Illinois, gives the names of some others not included in that list. These are the Kloepfer range, Barrow Lot, the Morrelli & Monti group of east and west, the Binsemer Diggings, the groups of small diggings on Furnace creek, the Beber Diggings, the Gaffner and Shuster ranges, in the same group with the Gaffner; the Whitham range; the Brendel, Eberhart, Widmer & Nolt, Monti, and Leonhardt, is another well known group of mines; the Wallis, Leonhardt and Klein crevices on the Morehead Lot, the Wallis Diggings, and the Mannett & Bassett Diggings, the Tourlin Lot, the DeToya Lot, and the Flege Diggings, the Lowe Diggings, and the Marfield Diggings.

These ranges and diggings are situated within a circle of about three miles in diameter, of which the city of Galena would be the center. They are principally on the west half of section 21, the north west quarter of section 16, the west half of section 9, the north-west quarter of section 28, east fractional section 8—all in township 28, range 1 east, 4th P. M.; and on the east half of section 12, the east half of section 23, the south half of section 14, the north half of section 26, and the east part of section 27—all in township 28, range 1 west, 4th P. M.

The Vinegar Hill Diggings are about five miles north and a little east of Galena. The following ranges are known by the following designations: Baily, Gear, Meighen, H. Mann, Indian, Feehan, Blood, Campbell & Reppy, Furlong & Feehen, Talbot, Kennedy, Rogers, Hogan, Gray, Leekley, Beedle, Briggs, Manley, Myers, Bruno, Cottle, O'Mara, K. Orwick, Whim Range, Hawkin, Hart, Trover, Dugan, Liddme, Hoskin, Sidemer, Shattluck, Smelt, 15 Strike, Foley, H. H. Gear, Cooney & Ryan, Cox, Wylram, and Richards. These are located principally on fractional sections 14, 15 and 16, on fractional sections 20 and 29, on sections 21, 22 and 23—all in township 29, range 1 east, 4th P. M.; and on the east part of sections 24 and 25, township 29, range 1 west, 4th P. M. On the west part of the last section named, on the north-east corner of section 35, and on the north half of section 23, in the township and range last aforesaid, there are also groups of diggings not enumerated in the foregoing ranges. The Vinegar Hill mines are among the heaviest in the lead region, if we consider the amount of mineral they have furnished, but they are not now worked to a very great extent. These diggings extend in a somewhat north-east and south-west direction, over a tract of ground about three miles long, and not to exceed a mile in width. The shafts are sunk from about 50 to 90 feet deep, and penetrate in many instances the flint beds of the Galena limestone.

About three miles east and a little south of Vinegar Hill Diggings, the Council Hill ranges are located. The heaviest ones are situated on the north half of section 25, and the south half of section 24, township 29, range 1 east. They are known as the North Diggings, and cover a tract of about forty-seven acres, on which is over one hundred veins running north-east and south-west. The principal, medium, and smaller shafts, number nearly one thousand. The South Diggings, on the south of the Hill, are of small importance. The east half of section 36, township 29, range 1 east, and the west half of section 31, and the south half of section 30, township 29, range 2 east, have upon them diggings, the most important of which is the Rocky Point and Bolt's Lots.

Two or three lots and diggings along Fever river, between Council Hill and Galena, have yielded considerable mineral. The Burton, the Beeler, the Allan Rea, the Witmer, and the Wright lots, are the most important of these.

The Apple River Diggings, near the station of that name, on the Illinois Central Railroad, have yielded heavy bodies of ore. It is generally found in east and west shallow crevices, which did not hold their richness to any considerable depth.

A few scattered and unimportant diggings around Warren, complete the list of the diggings or sub-districts into which the lead fields of this county may be divided. It will now readily be seen, how small an area of the Galena rocks are productive lead-bearing rocks. All grouped together, would make perhaps less than a township of land.

Price.—The following table shows the price of mineral per thousand pounds, for the last 16 years, as delivered by the miner to the purchaser, at the mouth of the shaft. The ore was always paid for in gold, until the greenback era drove gold out of circulation:

1853	$37	1861	$28
1854	38	1862	40
1855	32	1863	55
1856	35	1864	75
1857	34	1865	65
1858	29	1866	60
1859	30	1867	60
1860	32	1868	55

Modes of Occurrence.—The crevices, veins and caverns in which the lead ore is found, are all, perhaps, cracks of shrinkage, into which the lead subsequently became deposited. The most common and widely disseminated form in which lead ore occurs, is known among miners as "float mineral." In many places the beds of red ferruginous and ochery clay have scattered through them galena in considerable quantities. It is generally found in small, irregularly-shaped pieces; sometimes in small grains, and sometimes in good sized crystals and chunks. Although widespread in its occurrence, no heavy bodies of mineral are found as float mineral. This form of mineral deposit results from the decomposition of the overlying Galena limestone, and in many cases it has settled down almost in the exact spot where the rock containing it once existed.

The mineral in the rocks occurs in what is known as "gash veins," and takes the forms of cog, dice, chunk, sheet, float, or fibrous mineral, as modified by circumstances. The predominant forms of deposit are the vertical crevices, and their modifications into the flat sheet and flat sheet openings. A crevice is a perpendicular or nearly perpendicular opening in the rocks, of varying width and depth. When filled with galena, the deposit is called "sheet mineral." The sheet varies in thickness, from a mere seam the thickness of a knife blade, up to three inches or more in thickness. The vertical crevices have a certain well-marked parallelism to each other, and an approximate north and south and east and west direction. The east and west are, by far, the most fully developed, and contain, by far, the largest deposits of mineral. These crevices are known by the various names of "leads," "lodes," "cracks," "veins," "ranges," and "diggings." The predominant form of mining in this county is that of the working of the vertical crevices. These are, by far, the most productive, and are characteristic of the upper and middle of the Galena limestone. The modifications of the vertical crevice are the crevice opening, pocket opening, chimney opening, and cave opening. They are all produced by the same causes. The crevice opening is an expansion of the crevice to the width of several feet in some instances; the cavity is often filled with red ocher and ferruginous clays, intermixed with loose stones and heavy masses of galena. The pocket openings are a succession of irregularly-shaped small openings in the crevices; the chimney opening is a rather large expansion of the crevice, extending upwards to a point resembling a chimney; and the cave opening is a large crevice opening, widening out into cave-like proportions, floored often with stratified clays. In these openings the galena is found lying over the bottom, mixed with the materials with which they are filled, crystalized in blocks or cubes over the walls, and hanging pendant from the roof. Some of the masses of mineral weigh thousands of pounds, and it is said one mass was found in the mines of Captain HARRIS, weighing half a million of pounds, and worth thirty-five thousand dollars.

These various openings are caused by the decay or disintegration of the rock on the sides of the crevices, owing to chemical agencies working round the mineral deposits. If the dirt remains where it was formed, the mineral and nodular masses of the rock will be found imbedded in it; sometimes the dirt has been removed and the lead alone remains.

Sometimes these openings extend to the surface clays; sometimes they are covered by a cap rock. They often extend into the flint strata, characteristic of the middle and lower portions of the Galena limestone. There is often several crevices, or sets of these various openings, one over the other; often three; sometimes as many as five; but one opening or set of openings is usually larger than the others, and contains the heaviest bodies of mineral.

The flat sheets or flat sheet openings are similar to the vertical, both as to themselves and their modifications, except that they lay flat in the rocks, parallel to their stratification, instead of standing upright. The saddle-shaped openings and pitching openings are but the transition openings from the vertical to the flat. These flat openings are characteristic of the lower parts of the Galena limestone and of the underlying Blue and Buff limestone, and are not found extensively developed in Jo Daviess county. The "green" or "calico" rock, below the flint beds; the "brown rock," and the "glass rock," are characteristic of the lower Galena limestone, their beds of passage into the Blue, and the Blue itself. In these occur the pipe clay openings; and in the Buff limestone the "lower pipe clay opening" is found. These are flat openings, filled with shaly limestone and a peculiar clay, from which they take their name. These lower flat openings are also peculiar in having more of the associate mineral deposits, such as tiff, blende, the ores of zinc, etc., than the upper vertical openings.

In this connection I do not intend to say much as to the origin of the lead ore in the North-west, nor to speak of the various theories as to the origin and deposition of mineral deposits in general. The question as to the origin of our lead, is unsettled, perhaps. J. D. WHITNEY, the best living authority on the Galena lead basin, believes the galena and its associate minerals were deposited in the aqueous or humid way in the crevices of the rocks, and that the veins were filled from above downwards. This theory supposes that the metals were held in solution in the waters of the primal ocean, in the form of sulphates, and were deposited in crystaline forms in the shape of the sulphurets. The decomposition of organic vegetable or animal matter, throws off a sulphuretted hydrogen gas, which, acting upon solutions containing sulphates, is supposed to cause a reduction and precipitation of the metals in the form of sulphurets. The decay of sea plants and the abundance of organic life in the Trenton Period, is thought to have been sufficient to produce the great precipitation of lead ore found in these rocks. The writer argues his theory with ability, and it may now be considered as the one generally received. I hazard the suggestion, however, that electrical action may have had much to do with the precipitation, crystalization and arrangement of these minerals.

Early and Recent Mining Processes.—The primitive mining processes in the Galena lead basin were of a very simple character. Two men selected the spot where they wished to try their fortunes. They were generally guided by certain signs in making the selection, such as depressions in the ground, unusual luxuriance in the growth of vegetation, color of the clay, or ravines supposed to indicate crevices in the rocks below. A shaft was sunk through the clay, and cribbed by building up timber, until the rock was struck. A rude windlass, bucket and rope, a few shovels, picks and pieces of tallow candle, constituted all the tools needed, to which was sometimes added a few blasting tools. If a crevice was struck it was followed down, and drifts were driven from it in various directions. The man at the top laboriously hoisted with his windlass the material necessary to be removed. The digging was abandoned when worked down to the water, or a pump is put on driven by horse-power. The mineral is brought to the bottom of the shaft or rude car, running on wooden rails. Instead of sinking a shaft, an inclined plane or drift is run into the hill, in case the outcrops of the rock show lead crevices. If a heavy body of mineral is found at any considerable depth, a whim is put on. This is a large wooden wheel or barrel, revolving at some highth above the ground, propelled by horse-power, and containing coils of a strong rope, to which is attached rude cars or tubs, so arranged in many instances that one goes down as the other comes up. With the whim and horse-power pump, a range can be worked considerably below the water level. Most of the prospecting and much of the mining has been done over the lead district in this rude way. It has proved very effective, and will be resorted to for a long time to come, both for prospecting and shallow mining. Gradually, however, more advanced and scientific processes of mining were resorted to. Costly *plants* of machinery, including steam engines and expensive pumps and mining tools, were put to work in the heavier mines, especially where it was desirable to work below the water level. Prospecting is also now done to some extent by driving adit levels, so as to cut and prove all the parallel ranges in a hill or group of diggings by one level. The level also sometimes drains a large group of mines to a lower depth than could have been worked before the level was carried into the hill.

The first attempts at smelting were also quite rude. The Indian squaws smelted the ore by roasting it in a rude stone furnace, in which they were able to melt out but a small portion of the lead. The log furnace succeeded this when the white men began to work the mines. In these some large logs were rolled into an area inclosed on three sides by low stone walls. Upon the logs fuel and ore was piled alternately to the top of the walls. The fuel was kindled and the "charge" melted, the flowing molten lead finding its way in fiery streams to some place prepared for its reception. It took nearly a whole day to melt one of these charges, and not much more than half the lead contained in the ore was smelted out. A "reverberatory furnace," in which the ore was melted in an oven, where the blaze passed over and through the charge, was next tried, and was a great improvement in smelting processes.

But they have all been superceded of late years by the Scotch Hearth or Blast Furnace, now universally used throughout the lead region. It consists of a cast-iron box, shallow and open at top, and about two feet long and less than two feet wide. In the side and near the bottom of this box is a hole into which the nozzle of a strong bellows is placed. The bellows is generally run by water-power. A huge chimney is built over the hearth, resembling a cooper's chimney. The following detailed description of the Scotch Hearth is taken from an article in *Harper's Magazine*, and is understood to be the production of a lady of Galena, whose name I do not know:

The hearth "consists of a box of cast-iron, two feet square, one foot high, open at top, with the sides and bottom two inches thick. To the top of the front edge is affixed a sloping shelf or hearth called the work stone, used for spreading the materials of the "charge" upon, as occasionally becomes necessary during smelting, and also for the excess of molten lead to flow down. For the latter purpose, a groove one-half an inch deep and an inch wide runs diagonally across the work stone. A ledge, one inch in thickness and hight, surrounds the work stone on all sides except that towards the sole of the furnace. The hearth slopes from behind forward, and immediately below the front edge of it is placed the receptable or "melting pot." An inch from the bottom, in the posterior side of the box, is a hole two inches in diameter, through which the current or "blast" of air is blown from the bellows.

The furnace is built under an immense chimney thirty to thirty-five feet high, and ten feet wide at its base. Behind the base of the chimney is the bellows, which is propelled by a water-wheel, the tuyere, or point of the bellows, entering at the hole in the back of the box. The fuel, which consists of light wood, coke, and charcoal, is thrown in against the tuyere and kindled, and the ore is placed upon the fuel to the top of the box. The blast of air in the rear keeps the fire burning, and as the reservoir or box is filled with molten lead the excess flows down the grooved hearth into the "melting pot," under which a gentle fire is kept, and the lead is ladled from it into the molds as is convenient. Before adding a new "charge" the blast is turned off, the "charge" already in is turned forward upon the work stone, more fuel is cast in, and the "charge" is thrown back with the addition of fresh ore upon the wood. The combustion of the sulphur in the ore produces a large amount of the heat required for smelting. The furnace is thus kept in operation sixteen hours out of the twenty-four.

The ore is of different degrees of purity, but the purest galena does not yield on an average over sixty-eight per cent. of lead from the first process of smelting. The gray slag is very valuable, though the lead procured from it is harder than that of the first smelting. There is left about 75,000 of gray slag from each 1,000,000 pounds of ore. The slag furnace is erected under the same roof with the Scotch Hearth, and has a chimney of its own a few feet from that of the hearth, and the "blast" is secured from the same water-power by an additional blast pipe driven by the same wheel. It consists of a much larger reservoir, built of limestone, cemented and lined with clay, with a cast-iron door in front, heavily barred with iron. It will burn out so as to require repairs in about three months. Open at the top, the slag and fuel are thrown in promiscuously. Under the iron door is an escape for the lead and "black slag." In front of this escape and below it is the "slag pot." It is an oblong iron basin about a foot in depth, with one-third of its length partitioned off to receive the lead, which sinks as it escapes, while the slag, being lighter, flows in a flame-colored stream forward, and falls into a reservoir that is partly filled with water, which cools the slag as it is plunged therein. As the reservoir fills, a workman shovels the scoriæ into a hand-barrow and wheels it off. This scoriæ is black slag, and worthless, the lead having now been entirely extracted. The smelter now and then throws a shovel full of gray slag into the furnace, which casts up beautiful parti-colored flames, while the strong sulphurous odor, the red-hot stream of slag, with the vapor arising from the tub wherein the hissing slag is plunged, the sooty smelters, and the hot air of the furnace room, suggest a thought of the infernal regions. Outside, the wealth of "pigs," not in the least porcine, gives one a sort of covetous desire that, if indulged in, we are taught leads directly to said regions. The Scotch Hearth requires less fuel than any other furnace. It "blows out" in from six to twelve hours, while the Drummond furnace was kept in operation night and day."

After examining the process of smelting, I concluded the above description could hardly be improved on, and hence give it a place in this report.

The Future.—The future of the lead region deserves a passing thought. It is an interesting inquiry as to how extensively the mines will be worked hereafter, and how nearly the supply of lead ore is now from becoming exhausted. That the present mines are far from being exhausted is well known. Many are temporarily abandoned on account of water. These will doubtless be worked extensively hereafter by heavy capitalists and companies, who will be able to put steam pumps on, and thus conquer the difficulties in the way of making them remunerative. Deeper and more scientific mining will be carried on in the future, and new mines and heavy bodies of mineral will yet be discovered. It is a fact, that not much over a tenth of the supposed productive lead district has yet been prospected. In all human probability, when these unexplored lead regions have been thoroughly and scientifically examined, other heavy bodies of mineral will be discovered. Science has already done an important work in the lead basin, and made many valuable suggestions, which the practical miner is now willing to avail himself of. Science has yet a great work to do, taking capital by the hand and exploring this lead field in search of hidden treasures yet locked in the bosom of the earth. It is the opinion of many practical miners and amateur geologists, that labor in the lead field will now pay more uniformly and better than in any past period of its history, and that an intelligent expenditure of capital in this direction is one of the very best investments.

The Romance of Mining.—Lead mining, like all other mining, is attended with hazard and uncertainty. The instances are numerous where poor, hard working miners have suddenly found themselves in possession of a vast fortune. Indeed this phase of lead mining is so common that it hardly excites comment in the localities where it occurs. The case of the purchase and discovery of the Marsden mine is an illustration in point. The history of Mr. CHAMPION'S twenty-five years of persevering labor in running a certain adit level, until he had bankrupted himself and almost bankrupted some of his generous friends, to be at last rewarded with a magnificent fortune, is one example of a numerous class of cases. The instances where workmen have slowly and laboriously sunk their shafts and run their drifts through the solid rock and finally abandoned the enterprise into the hands of some new man, whose very first efforts struck the "discovery" which the former proprietor had just missed, are by no means rare. Instances of hope long deferred until the heart was made sick, to be at last elated with the looked-for discovery, are numerous enough to make a book.

The hazards, the expectations, the disappointments, the perseverance, if fully written out, would contain much that is wonderful and even romantic. The unwritten history of almost every great mine in the lead region would have in it some chapter of romance, some story illustrating some phase of human character. Gold mining has its wonders and wonderful effects on the human mind; the finding of wonderful oil deposits has been the cause of some curious chapters in human history; lead mining, where sudden fortunes have been poured into the laps of those unused to fortunes, or where steady persevering toil, with its high faith in its own unyielding endeavors, has at last been rewarded in the most ample manner, has its curious chapters bordering upon the romantic. The story of unrequited labor must sometimes be written in writing the history of the mines; but far oftener the historian of the lead mines may record that steady persevering effort hardly ever fails at last in obtaining its rich reward.

In addition to my own observations upon the geology of this county, I take pleasure in acknowledging valuable aid derived from Mr. HOUGHTON'S pamphlet upon the MARSDEN Mine, D. WILMOT SCOTT'S little business directory of the county, the copy of "*Harper's Monthly*" above referred to, and suggestions obtained from Captain E. H. BEEBE, of Galena, and Dr. LITTLE and HENRY GREEN, ESQ., of Elizabeth.

CHAPTER III.

STEPHENSON COUNTY.

This county is bounded on the east by Winnebago, on the south by Ogle and Carroll, on the west by Jo Daviess, and on the north by Green county, in the State of Wisconsin. It thus lies in the northern tier of counties in the State, and is the second county eastward from the Mississippi river. It is twenty-seven miles wide, from east to west, and about twenty-one and a quarter miles from its northern to its southern boundary line; and contains about five hundred and seventy-three square miles. The northern part of the county, according to surveys made by the Illinois Central Railroad Company, averages about seven hundred and twenty-three feet above the level of the Mississippi river at Cairo, about four hundred and fifteen feet above the level of Lake Michigan, and about one thousand feet above the level of the sea. The southern part of the county averages some two hundred and fifty feet lower than these figures. The general level of the county, it will thus be seen, presents a gentle slope to Southern, sunny skies. The general surface or face of the county is composed of gently undulating and rather rolling prairie land, interspersed with small groves, and narrow belts of timber land skirting the streams. A small portion of the county is made up of barrens and oak orchards or openings. The prairie soil is of unsurpassed fertility, and under a high state of cultivation and improvement. It is not so black and deep as the prairie soil further south; but is drier, sandier, lighter or more chocolate colored, producing in great perfection all the staple crops of the northern part of the State. The oak openings and other poorer portions of the county produce the best wheat and other cereal grains, the best potatoes raised in the State, very excellent apples, and pears of the hardier varieties, and with proper care and cultivation will nourish the vine and ripen its fruitage to a greater extent than is now dreamed of by the grape growers and wine makers of the West. Indeed, the day is coming, in our opinion, when its gravelly hills and loess clays will not only blush with the purple clusters of such vines as best endure our cold climate, but will also become sources of profit to their cultivators and sources of exquisite pleasure to those who delight in using healthful, invigorating, pure wines. The soil of this county, as of all these northern counties, also produces and ripens in great perfection, the currant, gooseberry, strawberry, raspberry, and other garden fruits.

The county is reasonably well watered with streams, which flow in various directions over its surface. Of these, the Pecatonica river is the largest and most important. It enters the county about seven miles from its northwest corner, flows in a course a little south of east to Freeport, bends round to the westward at this latter place, and enters the county of Winnebago, not far from the center of its western boundary line. Its waters are turbid, and muddy as the "Yellow Tiber;" its course is serpentine and crooked beyond comparison, winding and doubling upon itself in the most capricious manner; its current slow flowing, treacherous and silent, notwithstanding the general difference in level between the northern and southern portions of the county, affording few water powers, and they of limited fall, but heavy and constant in their action. This is pre-eminently true of the six feet fall at Freeport, but hardly so true of the power at Martin's mill, just across the northern line of the county. Indeed, so far as a description of the stream is concerned, the dispute as to the Indian significance of the name Pecatonica—"muddy water" and "crooked stream"—might be well reconciled by adopting both meanings, and applying them with much truth to this tortuous body of flowing mud. Along portions of its course, its oozy banks and stagnant waters might breed miasms and fevers, were its influences not counteracted by the general healthfulness and salubrity of the climate of Northern Illinois. Yellow creek enters the county almost at the center of its western boundary line, and flows into the Pecatonica two or three miles below and east of Freeport, its general course being a little south of east. Its waters have a yellowish, somewhat creamy color, and are slow flowing like the Pecatonica. The color of its waters is derived from the Cincinnati shales, along its banks, which dissolve and mingle with the water like yellow cream with muddy coffee. Its course is not so crooked as the stream with which we are comparing it. It wanders about in long undulating curves, instead of short, abrupt doublings. It affords few water powers, and they of limited extent. Cedar and Richland creeks rise almost entirely within the county towards its northern and central parts, flow southward, mingle their waters together within a few miles of the Pecatonica, and empty into the latter stream a few miles above Freeport. Both these streams afford light, but rather constant water powers. The mills of the Hon. JOHN H. ADDAMS are located upon the former, at the romantic little village of Cedarville; the Sciota mills are located upon the latter, after its union with the former. Both these streams have bright, clear waters. They are not mountain born, but are fed by prairie and woodland springs, almost entirely within the boundaries of the county lines. Rock run enters the county, about four miles from its north east corner, and empties, after running about twelve miles on an air line, into the Pecatonica about one and a half miles west of where it crosses the western line of Winnebago county. This is a beautiful little stream, affording a few very light, and not very valuable water powers. It goes babbling and murmuring along through rich prairie farms and woodland groves, until within half a dozen miles of its mouth. Here the banks rise to precipitous, brush-covered, timber-crowned hills, and in a few miles further, the low alluvial bottom of the Pecatonica is entered, through which it seeks its way with less haste into the dirty waters of the latter stream. Crane's creek is a small and short prairie stream or brook, flowing into the Yellow creek, nearly south of Freeport, coming in from near the center of the southern boundary line of the county. Besides these, there are many brooks, rivulets and little streams in various parts of the county, watering it reasonably well both for agricultural and stock raising purposes. Nor should we omit to mention, in this place, the bright, flashing, singing little Silver creek, which runs northward through the town of the same name, and finds its way into Yellow creek, not far from its mouth.

In comparison with most of our northern counties, Stephenson might be said to be well timbered. The Pecatonica is skirted, more especially along its eastern bank, with a body of rather heavy timber, spreading out northward into the town of Oneco for a considerable distance. Yellow creek is fringed, for a part of its course, with a scattering growth of white oak groves and clumps, spreading across from Mill Grove towards Eleroy and the Sciota mills, into oak openings and a somewhat rough soil. Part of the town of Loran, in the south-west part of the county, is a regular white oak barren, with scattering trees and some brushwood. Crane's grove, lying south of Freeport, is about three miles long and more than a mile wide. Lynn and walnut groves dot the broad expanse of prairie in the north-eastern part of the county, with a grateful change in the monotony of the prairie view. Cedar creek has some good timber along its course. Richland creek is shadowed by the heaviest body of good timber perhaps in the whole county.

The prevailing timber consists of white, black and burr oak, sugar maple, black walnut, butter-nut, pig-nut, shell bark and common hickory, slippery and water elm, yellow poplar, with occasional laurel, red cedar, white pine, paw-paw, and some of the rarer oaks, interspersed. Sumach and hazel also abound in and around all the groves. Wild cherry, honey locust, linden or bass wood, ash, cotton-wood, sycamore, and some other varieties of timber are more or less to be noticed, and in some particular localities are found in considerable abundance.

Such, in brief, are the topographical features of Stephenson county—a county whose agricultural resources are not surpassed by those of any county in Northern Illinois. Indeed, it would be hard to find an equal area anywhere in the State, whose soil is so universally good, productive and teeming in every bountiful gift to the industrious tillers of the earth. No mineral wealth, or peculiar manufacturing facilities, will attract to this county the attention of the adventurous; but for those resources which are derived from a rich soil and abundant agricultural capabilities, this favored county may well claim a lasting pre-eminence.

Geological Formations.

The geology of Stephenson county is of a very simple character. After leaving the surface geology, the first formation met in a descending order is the Niagara limestone, succeeded in regular order by the Cincinnati shales, and the three divisions of the Trenton period, namely, the Galena, Blue and Buff limestones of the old Trenton seas. The following section shows the actual, worked exposures of these rocks as measured in the quarries by the writer of this article. In no instance, perhaps, do the measurements exhibit the maximum thickness of the formations. At some points where measurements were made, the rocks of the formations measured undoubtedly extended downwards to an indefinite extent, and in the few particular instances where the bottom of a formation was distinctly identified, denuding agencies had carried away much of the superincumbent mass. A section thus constructed might be styled a surface section of the formations indicated, and in a level country, where no borings had been made, would be the only attainable one to be had.

Section of worked outcrops.

Quaternary deposits, consisting of clays, sands, gravels, surface soils, etc	10 to 65 feet.
Niagara limestone	23 "
Cincinnati group	40 "
Galena limestone	75 "
Blue limestone	38 "
Buff limestone	40 "

Each of these groups or formations outcrops at some place or places in the county. Some of them are the immediate underlying rocks over large portions of the same.

As further illustrating the geological formations of this county, and more especially those which lie deep down in the earth, we now give an imperfect section, obtained from the borings of the rocky farm oil well. This well was commenced, we believe, in 1864, and continued on through a great part of the year 1865. At that time the oil fever was prevailing extensively. Some surface indications were noticed in a small brook running through the north part of section six, in the town of Lancaster. A company was formed, an engine was obtained, and a hole six inches in diameter drilled into the earth for over eight hundred feet. No oil was obtained, and no indications of oil noticed after leaving the surface, and the enterprise was finally abandoned. Although very unprofitable to the company, this boring was not devoid of scientific interest. After boring about eight feet through the overlying soil and clays, the Galena limestone was struck. No very accurate record of the material passed through for the first one hundred and twenty feet was kept, but from the fact that the Galena limestone outcrops heavily at Cedarville, only a mile or two distant, being there seventy-five or eighty feet thick in the exposure on Cedar creek, we believe the well, in this one hundred and twenty feet, passed out of the Galena limestone, and reached perhaps a considerable distance into the Blue limestones, immediately underlying. Commencing at one hundred and twenty feet beneath the surface, we give a section of strata and materials bored through, until the depth of six hundred and eight feet was reached, as indicated by the detritus brought to the surface by the auger. No record of the last two hundred and fifty feet seems to have been kept.

Section of Oil Well on Rocky Farm.

120	to	130	feet,	blue limestone and mud veins	10	feet.
130		146	"	gray limestone, containing crevices	16	"
146		168	"	shales of various kinds	22	"
168		375	"	St. Peter's sandstone, soft, very white	207	"
375		484	"	red sandstone, with tough, paint-like mud veins	109	"
484		487	"	yellow sand, like surface sand	3	"
487		491	"	quick sand and salty water	4	"
491		494	"	bright yellow, fine, salty sand	3	"
494		501	"	slate of chalky color and nature	7	"
501		520	"	snuff colored, slaty rocks	19	"
520		532	"	sharp, slate colored sand	12	"
532		564	"	dark red stone, like soap stone, with thin flinty strata and iron pyrites	32	"
564		586	"	bright red stone, slightly oily	22	"
586		608	"	dark, reddish slate, with iron pyrites	22	"

At the depth of about sixty feet from the surface, some dark colored carboniferous shales were struck. These must have belonged to the Blue limestones underlying the Galena, and perhaps are near the dividing line between the two. From thence to the depth of one hundred and sixty-eight feet, the Blue and Buff limestones of the Trenton period were undoubtedly the rocks passed through. The next two hundred and seven feet was the St. Peter's sandstone. There could be no mistake as to this; the auger brought it up, pure, crumbly and white. The next one hundred and nine feet, although it strongly resembles the St. Peter's sandstone when stained by water holding iron in solution, belongs, perhaps, to the Calciferous sandstone, or Lower Magnesian limestone of the North-west. The next one hundred and twenty-four feet almost loses its identity, but perhaps belongs to the lower Calciferous sandstone and to the Potsdam sandstone. Chemical analysis of the materials brought to the surface, aided by a strong magnifying glass, may show these surmises to be partially untrue. We admit they are little better than scientific guesses after studying the above section, and examining with the naked eye and the touch specimens of the abraded materials, preserved as brought up by the drill.

We have attached some importance to the above section, because it is a matter of much interest to the citizens of Stephenson county, and because it afforded to the writer the only opportunity he had, in all the country examined the past summer, of making even a partial examination of the deep, underlying formations. It also settled another question then agitating the public mind in this part of the State. Before this experiment, geological science had foretold that no productive oil deposits would or could be found in this part of the country. It had predicted this from knowledge of the underlying strata, and their inability to collect and preserve the oily treasures of the earth. But capitalists lacked faith in the teachings of science, and acquired in the school of experience the lessons which they would nowhere else learn. The experiment of this well had a wonderful influence in allaying the oil fever in this region.

We cannot leave this subject without rendering our acknowledgments to F. E. DAKIN, Esq., of Freeport, to whom we are indebted for the figures in the above section, and also for small and carefully labeled specimens of the materials brought to the surface, during every ten feet of the distance to which the well was sunk.

We shall now proceed to describe, in detail, these outcropping geological formations.

Quaternary Deposits.—These deposits cover unconformably the underlying rocks to a varying depth. At some places they are five or ten feet thick; at others they perhaps extend in thickness to sixty or seventy feet. To say that they average twenty-five or thirty feet all over the county, would, perhaps, be placing the figures safely within the bounds of truth. If all this accumulation of deposited materials could be removed, the surface of the underlying rocks would present a very rough, uneven surface. Scooped out depressions, extending through overlying formations and over large portions of the country, presenting, if filled with water, the phenomena of broad, shallow lakes, would be seen. The mounds, rising like watch towers over these prairies (resisting, on account of some local cause or hardness, the denuding agencies that carried away the rest of the formation), would appear like islands in the surrounding waste of waters. The rocky surface thus left, so far as we can judge from the limited examinations we are now able to give that surface, would be unsmoothed by water current and unscratched by glacier, but would be everywhere uneven, rough, and covered with unworn fragments of stone.

Along the narrow bottoms of the Pecatonica may be noticed a strip of alluvium proper. At some places it is very narrow, at others it extends to one or two miles in width. The same deposit may be observed at a few localities along the Yellow creek bottom, and also along the narrow bottoms of some of the smaller streams. The deposit, however, is of limited extent; it is rich, fat, and heavy as an agricultural and timber soil. Along some of these streams the low, bald hills are found to be composed of the loess marls and clays; but this deposit is also of quite limited extent in the county. All the rest of these superficial deposits belong to the sands, clays and gravels of the drift proper. These clays and clayey sands, however, do not very strongly furnish the evidences of deposition or transportation. They seem to partake, in part at least, of the nature and character of the rock formations lying immediately below them. In every instance examined this seemed to be true. Where the Galena limestone is the underlying rock, the appearance was somewhat as follows: First there was the prairie soil and clayey subsoil, at most only a few feet in thickness; this was succeeded by a reddish-brown clay, mixed with flints and pieces of cherty Galena limestone; then came the clay and pieces of the limestone preserving their regular stratification, the limestone becoming more abundant in the descent, until the solid rocky strata was reached. In a few instances this overlying clay is creamy in color, and almost limey in texture; but the prevailing color is reddish-brown or red, and in many cases it is more or less mixed with sand. The clays overlying the Cincinnati shales also bear a resemblance to this formation, from which they are doubtless in part derived. They are of a creamy or more chocolate color, finer in texture and freer from sand. These superficial clays and loams certainly have the appearance of being the residuum left after frost and water had pulverized, and, by percolation, removed the more soluble portions of the uppermost parts of the formations below.

But, aside from these deposits, the gravel beds and boulders of the true drift period are not wanting in this county. That part lying west of the Illinois Central Railroad and south of Yellow creek—being mostly low, level prairie, underlaid mostly by the Cincinnati shales, and also that low, rich, level part between Waddam's Mound and the range of mounds running from the neighborhood of Warren towards the southwest, and underlaid by the Galena limestone—may almost be denominated a driftless region. Few boulders are seen over it, and few or no real gravel deposits can be found. The prairies north and east of Waddam's Grove have strewed over them numberless boulders, some black, some flame colored, and some combining the various colors of the metamorphic rocks. At one place, about half way between Waddam's Grove and Winslow, they are rolled into wind rows along the road, and used in part for the lane fences. Many of these are exceedingly beautiful, and many colored. They are the real "lost rocks," and must have been dropped from the slow moving icebergs, as they drifted along towards the south-west. All that part of the county north and east of the Pecatonica is characterized by these boulders, and by many deposits of gravel and gravelly clays, to be met in almost any of the low ridges of land. The same may be said of the eastern portion of the county, excepting that the deposits are not so extensive.

Some other formations belonging to the surface geology, such as fire clay, peat, bog iron ore, muck, and the like, will be referred to when we come to speak of the economical geology of the county.

The Niagara Limestone.—The superficial extent of the county covered by this formation is quite small. Waddam's Grove, quite a high elevation of land, two or three miles long and a mile or two wide, and located a little north-west of the town of Lena, is capped by the Niagara limestone. At French's quarry, near the top end of this elevation, facing towards Lena, there is an exposure worked to the depth of about fifteen feet. French's well, near the same spot, is forty-five feet deep, the upper twenty feet being sunk through this formation, and the lower twenty-five feet sinking into the underlying Cincinnati shales. At Blakesley's quarry, twenty-five feet of the same formation is worked into. This is about one mile west of French's, on the north face of the hill. Here they have worked down to the Cincinnati shales. The bottom layers in both these quarries are compact and solid; the top layers are thick, irregular, speckled and porous. A species of slender, rotton *Cyathophyllum* was the only fossil observed in these quarries. From the latter quarry the prospect towards the north and west is beautiful beyond description. The low, level, rich prairie, with its fields and meadows, barns and farm houses, skirted in the distance by the range of mounds, bending around like a distant amphitheatre into JoDaviess county, presents as fine a prospect, beneath a glowing June sun, as we ever beheld in any State.

Leaving this elevation, we next find the Niagara outcropping in the south-western part of the county. We would indicate its extent by a line, which should enter the county from the west in the town of Kent, some three miles south of Simmons' Mound, and then follow the general course of Yellow creek, keeping distant from that stream from two to five miles, until nearly opposite to Crane's Grove, then carried southward until the south boundary line of the county was reached, near its bisection by the Illinois Central Railroad track. This line would cut off that part of the county underlaid by the Niagara rocks. And even in this, some of the small streams which come into Yellow creek through this section cut into the Cincinnati group, and a band of the Cincinnati group, along Lashell's Hollow, where the little village of Loran is located, also discloses the shales and quarries of this group. We would change Professor WHITNEY'S map of this part of Stephenson county, to be found in the first volume of the Geological Survey of Illinois, so as to make the green ribbon or band south of Yellow creek, denoting the Cincinnati rocks, very much broader, and the color denoting the Niagara rocks very much less. This formation is not much quarried in this part of the county. At Big Springs, in Lashell Hollow, quite a quantity of stone have been taken out. Few fossils were observed, except that great quantities of some of the rougher Niagara corals lie strewn over the hills about Loran, consisting of two or three species of *Favosites*, and some imperfect *Halysites*.

Cincinnati Group.—The rocks and shales of this group cover but a limited extent of this county. All that part of Waddam's Grove, between the level of the surrounding prairie and the capping Niagara, is composed of the shales and rocks of this group. The gentle slopes of the ascent, and the creamy-colored waters from the springs, are an unfailing index of this formation. No quarries are opened in it, but it is here, perhaps, forty feet thick. The broad belt south of Yellow creek, crossing this stream in the township of Kent, extending up into the south-west corner of the township of West Point, as indicated on the general map, has been referred to sufficiently, perhaps, in speaking of the previous formation. About the village of Loran, the hills on either side of the creek, to their top, are composed of the Cincinnati rocks and shales. Many quarries are opened in the face of the hills, and fair building stone are obtained. The worked outcrops here are fifteen or twenty feet thick. As we follow the creek to the northward from here a few miles, the Cincinnati formation runs under, and the Niagara takes its place. In the half township of Erin, just west of the village of Eleroy, there is quite an elevation of land, covering several sections, and crowned with a scattering grove, which is made up exclusively of the Cincinnati formation. On the west end, at the little village of New Dublin, there is a quarried outcrop some forty feet deep. A Catholic Chapel is built out of stones from this quarry. It seems to be enduring the influences of the weather reasonably well. Although quite as high as Waddam's Grove, we did not detect any overcapping Niagara on this elevation. A bold and steep escarpment on the north side, caused by extensive quarrying, can be discerned from a long distance off, and is a marked feature in the landscape. The rocks here present a dry and baked appearance. Hardly a trace of a fossil could be seen. An accident here, to our pocket level, prevented an accurate measurement of this interesting mound. Crane's Grove, commencing about one mile north of Baileyville, and extending over several sections towards the north-west, is another of those elevations, left standing when the surrounding formation of the Cincinnati group was eroded and carried away. The worked outcrop near Baileyville, furnishes stone fit for ordinary foundation purposes, but entirely unfossiliferous. East of the Illinois Central Railroad track, in the township of Silver Creek, some isolated patches of the Cincinnati shales and clays may be noticed, but the formation in this direction soon gives place to the Galena limestone.

These quarries of the Cincinnati group afforded few fossils. In the little streams and on the hills about Loran, the *Orthis testudinaria* and *Orthis occidentalis* may be found in some abundance; but we have yet to find a Cincinnati quarry, except along the Mississippi river, abounding in even characteristic fossils.

The Trenton Limestones.—This formation, as now recognized by geologists, embraces the Galena, the Trenton proper or Blue, and the Buff limestones. These divisions are well marked and easily distinguishable, and in these reports we shall describe and refer to them by these well known names.

The Galena Limestone.—Nearly three-fourths of Stephenson county is underlaid by this well known division of the Trenton rocks. And inasmuch as the railroad cuts and the streams afford the best facilities to study the geologic formations of these counties, we shall first pass along them in our description of this wide extended member of the group. The Illinois Central Railroad enters the county at Warren, near its north-western corner. It passes over a low, smooth prairie, without outcrop or stone quarry to Lena. Waddam's Grove, which stands in this prairie, shows that the Galena limestone underlies it. At Lena there is a quarry and a lime kiln within a short distance of the town, exposing some fifteen feet in thickness. In about two miles further there is another. Both are on a little stream towards the north. Passing on towards the south-east the railroads exhibit several small sections in the top of the Galena beds, but does not afford any heavy section, until Freeport is reached. Just west of the city, along the track of the railroad, and near the banks of the Pecatonica river, in a low range of hills, three extensive quarries are worked, furnishing stone for lime, and for the large amount of building material needed. The first, nearest the city, is worked about eighteen feet deep. The rock obtained here is very soft, yellow, sandy, and full of cavities the size of a walnut. Where heaps of it have been removed, a considerable amount of sand is left scattered on the ground. The top layers of this quarry are so friable and crumbling, that hand specimens will hardly remain in shape. The second quarry exposes an outcrop of about twenty-four feet. The third is exactly similar to the second. Both of them are somewhat shaly towards the top, but rapidly grow massive and solid as they are worked into. These three quarries are within a short distance of each other. A few feet of reddish clay, with small stones intermingled, covers the strata where these quarries are opened. These are the last outcrops upon the Illinois Central Railroad. The Western Union Railroad enters the county on a line almost exactly south of Freeport, and passes out of it about four miles south of its north-east corner. Three miles south-west of Freeport it cuts through the top of the rock under consideration, exposing the usual red clay, and over this a gravelly subsoil. This cut is a small one. About three miles north-west of Freeport there is an exactly similar cut. About a mile further on towards the north-west is another, which measured one thousand feet long and twenty-four feet deep in the middle. Further on, and a little over a mile west of Rock City, is another cut three hundred and fifty yards long, and fifteen feet deep in the solid stone at the deepest place, and the stone covered by about ten feet of the usual gravelly clay. Here the stone is hard, glassy, conchoidal in fracture, and begins to assume the characteristics of the Blue or Trenton proper. One-half mile further on and nearer Rock City there is a cut about twelve feet deep, the lowest part exposing the real Blue limestones. Further on, and one mile east of Dakota, there is another cut into the Yellow Galena. The cut is not a large or important one. Further on, at the railroad bridge, over Rock run, there is a cut about twenty-two feet deep. The first five feet is the usual reddish clay; the next twelve feet is Galena limestone, assuming characteristics of the Blue, and the last five feet is into the real Blue itself. The union of the Galena and Blue, passing into each other almost imperceptibly, may be satisfactorily examined here. The next and last cut is about one-fourth of a mile east of Davis, almost on the county line. It is over one thousand feet long and about thirty-one feet deep; the upper seven feet is the usual clay, with some gravel in it; the lower twenty-four feet is Galena limestone, solid, a little bluish in color, and of a somewhat conchoidal fracture. In fact, all these exposures along the eastern part of the county, in their blue color, conchoidal fracture, and hardness, differ considerably from the Freeport quarries. They are lower down in the series, and assimilate somewhat into the character of the Blue below. So true is this, that in some of the exposures it is hard to fix upon the line of separation between the two.

From Freeport south, along this railroad track, no other exposures of the Galena limestone are visible.

Leaving the railroad cuts, the streams present the next best opportunities to trace the superficial area, thickness, and phenomena of this deposit. The Pecatonica river, about four or five miles after entering the county, strikes the Galena limestone, and for its whole distance in the county, exposes this formation where any rocks are exposed along its banks. There are no very good exposures, however, on this stream, except those at Freeport already referred to. At Bobtown, or New Pennsylvania, an outcrop is worked near the river; and at or near the mouth of Yellow creek, the formation is dug into in an old crevice lead mine. Richland creek and Cedar creek both expose the Galena rocks for their entire length. Both these streams have cut deep into the solid rocks, and at many places along their banks heavy outcrops and escarpments stand out in bold relief. At Beuna Vista, on the former stream, there is an outcrop of twenty feet, quarried into for its whole depth. At Cedarville, on the latter stream, the outcrop is seventy-five feet thick. A large quarry is here opened, out of which the stone in Addam's mill-dam have been taken. This is one of the most romantic little places in the county. The high, rocky hills, with their green crowns of evergreen cedars; the more than Cyclopean walls of solid rock, rising along the banks of the clear, shady stream, and the neat little village, all make it a point not soon to be forgotten. At the Sciota mills, below the confluence of the two streams, and in many places in that neighborhood, the same rocks are exposed and quarried. Crane's creek, where it washes the west end of Crane's Grove, exposes the Galena limestone. It is here quarried for the surrounding prairie to a considerable extent. The same limestone is worked into at Rosenstiel's quarry, near Freeport, to a depth of about twenty-two feet. A hard, gravelly, red clay covers this quarry to the depth of eight feet. Bands of chert also exist in the clay and in the top layers of the stone.

Leaving now the streams, we will mention some localities examined in other parts of the county. Burr Oak Grove, half way between Lena and Winslow, has near its eastern limits an interesting outcrop. About two and a half miles west of the latter place, almost every little prairie hill top is dug into, and several small quarries opened. An exposure of twenty-four feet was also examined at the lime kiln, a little south-east of Rock City. The top of this quarry is Galena limestone, but it gradually changes into the Blue before the bottom is reached. In the township of Ridott, the Galena is the underlying stone, changing into the Blue towards its eastern and south-eastern part. In the township of Oneco, the formation is heavily developed. In short, the outcrops of this well known formation, or division of the Trenton rocks, are so numerous that we do not deem it necessary to particularize them more fully, but shall briefly give the superficial boundaries and area, as marked upon our map of this region.

All that part of the county between the Pecatonica river and Yellow creek, except a small strip east and south of Winslow, and except the development of the Cincinnati group at Waddam's Grove, New Dublin, Kent, and along the banks of the Yellow creek, is underlaid by the Galena rocks. All that part of the county north and east of the Pecatonica river, except a strip in the bed of and along either side of Rock run, is underlaid by the same. The south-eastern part of the county, nearly up to the Pecatonica river, and nearly to the track of the Illinois Central Railroad, with the exception of a strip along the south-eastern corner, and a few isolated patches in the eastern part of the township of Silver Creek, is also underlaid by these same rocks.

Fossils.—Few fossils are found in the Galena limestone in Stephenson county. The characteristic *Receptaculites sulcata*, called by the miners and quarrymen "lead blossom," and "sunflower coral," is found at Freeport and Cedarville in great abundance, but good specimens are hard to obtain, on account of the friable nature of the stone in which it is found. At the former place, a specimen of *Receptaculites orbicularis* was noticed. Two or three species of *Murchisonia*, fragments of several species of *Orthocera*, one or two well known *Orthis*, two species of *Pleurotomaria*, a small *Bellerophon*, and a rather well defined *Ambonychia*, were the fossils most usually observed. They all exist in the form of casts, and perfect cabinet specimens are hard to find.

The Blue Limestone.—This, the middle division of the Trenton, is of limited extent in this county. Of course, in many places marked on the map with the color indicating the Galena, a shaft sunk down a short distance would strike the Blue limestone; but we now describe it as the surface rock, and only speak of it, where developed, as a surface rock. Rock run cuts into the Blue limestone soon after entering the county, and all along its banks, on both sides, until within a mile or two of its confluence with the Pecatonica, this rock outcrops and shows itself. Some of the high, rocky banks are overcapped with the Galena, but the usual rock is the Blue. At the railroad bridge of the Western Union Railroad Company, over Rock run, the railroad track is about six feet below the junction of the Galena and Blue. Stepping west, out of the railroad cut, there is a perpendicular descent of thirty-three feet, from the track down to the water level, making the whole thickness of the Blue, at this place, about thirty-nine feet. The lower part of this outcrop is very blue, the upper part yellowish, with thin strata, and gradually changing in lithological character, until the overlying Galena just east of the bridge, is reached. This is a very interesting section. One and a half miles below this locality is another quarry, opened in the west bluff of the stream. The outcrop is twenty-five feet thick. The top part is shaly and yellowish; the bottom becomes heavier and bluer in color. Some of the thin shaly strata are full of a small sized *Orthis*. These two outcrops are fair representatives of all the others along this stream. Leaving this stream we find no other outcrop in the county. Some indications of underlying Blue limestones prophecy its existence in the south-eastern part of the county, and we have so marked it on the map.

Some slabs, with fossils similar to those found in the Dixon marble, were picked up; these, with the fragmentary stems of encrinites, were the only fossils found. A small specimen of "sunflower coral" was found in the Blue limestone, at Rock run railroad bridge, the only one ever found by us in this rock.

The Buff Limestone.—The only place where this, the lower division of the Trenton, is developed in this county, is at Winslow. It is doubtless the underlying rock for a few miles below this place, and on both sides of the Pecatonica river, for this distance. Here it presents very much the appearance of a quarry in the Blue. The top is shaly, thin-bedded, and of a yellowish, chocolate color. At Martin's mill, in Wisconsin, one mile above, the outcrop is much heavier, the bottom layers more massive and very blue. Professor Whitney pronounces these exposures outcrops of the Buff, and the fossils seem to indicate that he is correct in this. The lithological character of the quarries would indicate the same thing, but in a less satisfactory manner. On either side of this strip of Buff, and within a short distance of its outcrops, the Galena limestone comes to the surface, so that the latter seems to rest unconformably upon the former, but in following the stream to the northward, a few miles above the mill, the St. Peter's sandstone begins to show its outliers. The quarry at Winslow is worked twenty-three feet deep, and at Martin's mill, thirty-five feet, and at both places it is some ten feet from the bottom of the quarries to the surface of the water. Geologically, the locality is one of the most interesting in this part of the State.

Fossils.—We found here many well preserved casts of fossils. Among them the most characteristic were *Pleurotomaria subconica*; a large *Orthocera*, five or six inches in diameter, and some six feet long, with a part of the shell still wanting; a *Cypricardites niota? Oncoceras pandion*; some two species of *Tellinomya*; and some other fossils, which will be mentioned in our catalogue of the fossils of this part of the State, in the prefatory chapter to these county reports.

Economic Geology.

The chief sources of wealth in Stephenson county are to be found in the richness and productiveness of its soil, and in its abundant agricultural resources. So far as our examinations go, this is the best agricultural county of its size in the State. It has less waste land than any other we know of. It has a larger number of acres under successful cultivation than any of its neighbors. And from this cultivation labor reaps a richer reward than California's golden mines can bestow, and as a result, unexampled prosperity attends the tillers of the soil, and through them smiles upon all other pursuits and avocations which wait upon successful agriculture. In her fat, rich soil, therefore, is contained the first and chiefest source of wealth in this county; the one which is nourishing all the rest, and fostering and building the city of Freeport in a wonderfully rapid manner. But aside from this there are other sources of wealth and industry demanding our attention.

Clays and Sands.—Almost anywhere beneath the soils and sub-soils, may be found clay beds, out of which an excellent article of common red brick can be manufactured. This is more especially true of the reddish clays overlying the Galena limestone. Beds of sand are also found, sufficiently pure for mortars and plastering purposes, but they are far less numerous than the clay beds. A tough, tenacious, dark colored fire clay also underlies some of the peat marshes, which has been dried and baked into a tenacious, light colored brick, as an experiment, but this is not, perhaps, of much economic value.

Quick Lime.—The more solid portions of the Galena limestone burns into a quick lime of excellent quality, and there are many lime kilns in the county. Certain portions of the Blue limestone also burn into a good lime, and at Martin's mill certain portions of the Buff are being successfully made into lime of fair quality.

Building Stone.—All the rocks hitherto described furnish building stone of better or worse qualities. The Niagara is quarried in several places. It furnishes a handsome colored, enduring building material, but is unshapely and unmanageable on account of its irregular stratification. The Cincinnati group, although considered an unreliable building material, is much quarried about New Dublin, and in that region. It comes out of the quarry in good shape, for light work, and does not crumble and decay, when exposed to the weather, as we have seen it do farther to the west. Barn foundations, houses, bridge abutments, and other such work, may be seen built out of the Cincinnati group, at many places in the western part of the county. The Catholic Chapel, before alluded to, is built out of this material, and does not, as yet, exhibit much signs of decay. Indeed, some of the bottom strata are massive, very blue, and excessively hard; but yet the Cincinnati group would not furnish stone suitable for massive and solid masonry, or for long continued resistance to the action of the elements. The Galena limestone furnishes a good material for the heavier kinds of masonry. It is a rough, unshapely stone, requiring much labor to lay it, but when well dressed and laid, it seasons into great hardness, and takes a beautiful cream or chocolate color. Nearly all the stone work in the city of Freeport, is built of this stone. The new gothic Presbyterian Church, just completed, at great expense, is a noble, imposing structure, whose walls were taken from the Freeport quarries. For heavy pier work, this stone is unequaled. The Blue and Buff both afford a good stone for building purposes. The upper strata are too thin and irregular, but the lower blue strata afford the most beautiful building stone to be found in this part of the State. The only difficulty seems to be, the great labor in quarrying, on account of the great amount of worthless materials to be removed before reaching the handsome and valuable portions of the quarries.

Minerals.—Some bog iron ore may be found in some of the marshes, but it is of little value and limited extent. Pieces of float copper have been picked up in the gravel-beds, but they are of rare occurrence, and come from regions far remote. Galena, or common lead ore, is and has been mined for, to some extent. There is an old crevice mine near the mouth of Yellow creek, that has often engaged attention in years past, but no heavy amounts of mineral have ever been taken from it. From the quarries near Lena, "chunks" as large as the fist have been taken. In the township of Oneco, a company of Freeport men prospected to a considerable extent, and obtained several hundred pounds of mineral. Near Weitzel's mill some "prospecting" has been carried on. Along the banks of Yellow creek, some "float mineral" has been picked up; and in almost any of the quarries, small bits of the ore may be detected. But none of these localities have shown heavy bodies of lead. Indeed, the Galena limestone, notwithstanding its general prevalence in this county, seems to be very unproductive of rich bodies of mineral wealth. The probabilities are, that no rich, or even good paying diggings will ever be discovered, for the simple reason that they do not exist within the borders of the county. Small deposits undoubtedly do exist, and will occasionally create some excitement, and invite the expenditure of mining capital, but, in our opinion, capital thus spent will never make remunerative returns.

Peat.—At several localities peat beds of some value have been discovered. On the farm of a Mr. WHITE, in township 26, range 9, a bed of about fifty acres exists. It is from three to six feet deep, and is underlaid by a tough, tenacious, dark-colored fire clay; the peat is of a rather poor quality, and with our present knowledge of preparing fuel from this substance, is, perhaps, of no great value as a fuel. Near Lena and Burr Oak Grove, very small beds were examined. On the low, level prairies south of Yellow creek, and ranging between Florence and Crane's Grove, almost every swale and marsh has in it more or less peat. One of these beds is quite extensive, and will become valuable as soon as the peat experiment succeeds. It is found in the township of Florence, between sections twenty-five and twenty-six, the section line running along near its middle. It is from forty to fifty rods wide and about one hundred and sixty rods long, containing well nigh fifty acres. About one-half of it is owned by G. PURINGTON; the other half is owned by parties whose names we did not obtain. So far as we could obtain the depth of peat, it ran from six to about nine feet. Careful borings would, perhaps, show a greater depth. Through its center, a small stream of pure water runs in a little ditch dug to drain the marsh. The current of the water is rapid, on account of the great fall along the ditch. At the lower end of the marsh large bodies of the peat have broken off, turned over, and slidden down the declivity for several rods along the declining, underlying, slippery clay, resembling the action of ice blocks sliding away from the lower end of an Alpine glacier. The peat is somewhat fibrous in texture. When cut out in square, brick-shaped blocks, and dried, it is light and porous, but burns with a light, white-colored flame, making little smoke, and leaving a light, chocolate-colored ash. On account of its lightness, fires made from this fuel would have to be often replenished. No peat machines have yet been tried in this marsh, but there is no reason why this peat could not be manufactured into a valuable and pleasant fuel, by the aid of a good condensing machine. The ease with which this bog can be drained, and its proximity to one of the depots of the Western Union Railroad, afford peculiar facilities for manufacturing the fuel, and transporting it when so manufactured.

In addition to being used as an article of fuel, peat might be extensively employed as a fertilizer of the soil. If dug out of its native bed, slightly dried to reduce the labor of handling, and mixed with a small amount of wood ashes or quick-lime, it makes a fertilizer equal to the best barn-yard compost. The mucks and poorer qualities of peat answer this purpose about as well as the finer qualities. The ashes or lime correct the natural acidity of the peat itself, and sweeten what would otherwise be too sour an application to the soil. Lime can readily be burned from any of the neighboring quarries. The wood used would not only change the kiln into the lime required, but would leave a large amount of ashes to be used for the same purposes for which the stone was burned into lime.

We have much faith in the future economic uses of peat. And although we would advise due caution in the expenditure of money in experimenting with it, nevertheless we would like to see some of the Stephenson county people expend some capital in developing what we believe to be a source of material wealth. The peat experiment is not yet, perhaps, fully solved, but whoever does fully solve it, will not only enrich himself, but will confer a great blessing upon the inhabitants of these northern prairie counties.

CHAPTER IV.

CARROLL COUNTY.

Physical Geology.—Carroll county is situated in the north-western part of the State of Illinois, and is bounded north by Jo Daviess, east by Stephenson, south by Ogle, Lee and Whiteside, and west by the Mississippi river. It contains an area of about 450 square miles. By surveys of the Illinois Central Railroad, its elevation above Lake Michigan is about 400 feet, and above the mouth of the Ohio river at Cairo about 800 feet. About one-third of the county, the north-western, is somewhat rough, being mineral, or "lead-bearing" land. The surface of this is hilly, and sparsely timbered, but in the valleys, along the streams of this part of the county, many excellent farms have been opened. The usual alluvial bottom skirts the Mississippi, being from half a mile to four miles in width. Immediately adjoining the river there is a belt of heavy timber; but the rest of this bottom is composed of drifted sand banks, marshy swamps, and rich tracts of the best pasture and farming lands. The southern and eastern parts of the county are composed of gently rolling prairies, with here and there an island-like grove, as if the fingers of the retiring ocean had stroked the soft surface into swelling undulations. The agricultural portions of the county are perfect garden spots—rich in their almost virgin soil and manifold resources of wealth. Nor is the county wanting in picturesque scenery. Carroll creek, flowing west through its center, and Plum river, running through its mineral land, have each cut channels deep into the underlying rocks. These are piled about in massive grandeur—are crowned with evergreens; and are, in many cases, the abodes of wonderful echoes. Above Savanna, along the Mississippi river, the huge towering Niagara rocks lift their heads like a Cyclopean wall.

Geological position.—We are deep down in the geologic world—almost in the line of union between the upper and lower Silurian systems. Three distinctly marked groups of the rocks outcrop in Carroll county. These are the Galena limestone, Cincinnati group and Niagara group. Above these are the usual deposits belonging to the Quaternary system.

The Galena Limestone.—This is a massive, grayish, yellowish or brownish-drab colored Magnesian limestone—friable and coarse-grained near its union with the clays, but very solid in its lower stratification. In Jo Daviess county it is estimated to be about 250 feet thick; in this county it has never been accurately measured, but is perhaps somewhat thinner, as we are on the edge of the lead basin. Its heaviest outcrop commences near the geographical center of the county. Thence westward heavy ledges of it outcrop along the banks of Carroll creek almost to Savanna. North of this little stream similar outcrops may be found along the banks of Plum river. The former of these streams especially, has cut its channel deep into this rock. Along this stream an anticlinal axis seems to run, as the rocks dip slightly in both directions from the creek, and a slight upheavel must have once taken place here. Along the ridge of elevation thus formed a fissure naturally would be left. The frost, the rains, and the tooth of old Father Time disintegrated, wore down, and gnawed away the rocks until the fissure became partially filled. This, in process of time, formed the little valley in which Carroll creek now runs.

This is the famous "lead-bearing rock" of the North-west. The ore occurs in fissures and caverns running through the rock, in the form of what the miners call "sheet" and "cog," or crystalized mineral—the common sulphuret of lead. In the reddish clay overlying the rock, and formed by the decomposition of its upper beds, "float" ore is found; never, however, in very large quantities. Mining operations have never been carried on on a large scale, or on scientific principles. The "diggings" extend for several miles north and west of the town of Mt. Carroll. The pick, spade, common windlass and bucket, are the only machinery in use. Little more than a livelihood has ever been made by these primitive miners. For a long time it was thought a system of deep mining would reveal heavy deposits of the ore. In two instances companies were formed, and a considerable amount of capital invested. In one instance water compelled the abandonment of the mine, and in the other nothing was ever found to repay a tithe of the expenses of the company.

This surface mining will still go on as a temporary employment for those whose other employments are not steady; but no one will probably be found willing to spend money enough to thoroughly test a system of deep mining. The deepest section of this rock, measured by me, is one hundred and fifty feet, but the bottom was not exposed, and extended down indefinitely.

The early writers have been treating the Galena limestone as a separate system. We believe it is now coming to be regarded as a member of the Trenton limestone, none of which latter rock outcrops in this county, although it is reached in sinking deep wells in the south-eastern part; and one quarry of the real blue Trenton limestone is now worked in Ogle county, two or three miles from the county line.

Of the characteristic fossils, the *Receptaculites Sulcata*, or "sunflower coral" of the miners, is the most usually observed, and very perfect specimens are sometimes found. The *Murchisonia obtusa* and *Lingula quadrata* also abound. *Orthocera*, several feet long; several species of the *Orthis*; corals of a number of species also abound. A very interesting species of trilobite has left its remains in these rocks; and we firmly believe that many new fossils will be found, when the quarries in this rock are carefully and scientifically examined. Of the economic value of this rock we will speak again. It is the underlying rock in perhaps two-thirds of the county, embracing the central, northern and eastern parts, being our chief building stone.

The Cincinnati Group.—The gentle slopes from the Mississippi bottom lands up to where the bluffs are capped with the castellated crags of the Niagara rocks, if exposed, would reveal outcrops of this group. Some of the small streams have cut down into this formation through the overlying Niagara. Johnson creek, winding in a sinuous course from the central to the south-western portion of the county, shows the same rocks, sometimes near the surface. One-half of the southern part of the county has this as the immediate underlying formation. About one mile below Savanna there is a fine outcrop, where the county road cuts the side of the hills. About one mile above Savanna there are considerable quarries opened in this formation, on the side of the bluffs. Here the formation, as near as we can measure, is 80 feet thick. This is the best place in the county to make a section. At some large springs, just at the level of the Mississippi, in a full stage of water, the group begins, resting solidly on the Galena limestone as a foundation. Far up the hillside, the overlying Niagara rocks are just as distinctly marked. In the railroad cut, on the Tomlinson farm, some four miles south-west of Mt. Carroll, may be found another, and perhaps the finest exposure in the county. At Bluffville, also, it is exposed by quarries. There are, however, few natural exposures of this rock. It soon disintegrates and crumbles away. Gentle hills and slopes, and graceful undulations are characteristic of its physical geography. Many springs burst out from the bases of these hills, and marshes and swampy places are not unfrequent. Shales and shaly limestones compose a large part of the rocks of this group; but its lower beds are sometimes solid and massive enough for a building stone, and even contain lead in small quantities. These shales are of a bluish-white color. Their particles are finely comminuted, as if deposited in deep, peaceful seas.

A vast amount of carbon is contained in the black shales of this group. Specimens taken from near Savanna, and from the Beers Tomlinson farm, are almost as black as cannel coal, and burn with an oily bright flame for a considerable time. Misled by this, some capital has been expended at the latter place in boring for coal, and nothing but experience will convince those engaged that such a search is useless.

One of our citizens also succeeded in extracting some oil, which he pronounced petroleum, out of similar specimens. When the great oil excitement arose in the country, an oil company was formed here, and but for the advice of the geologists, this company would now be spending its money in a vain effort to strike oil. The geologist of Iowa, Prof. WHITNEY, estimates that the carbon of these rocks, if gathered into one strata, would form a bed twenty-five feet thick.

Whence came this mass of combustible matter in these old Silurian rocks? No geologist, to my knowledge, has undertaken to answer this question. Is it of organic origin, the remains of an ancient vegetation? Is it the result of animate life, the coral? HALL's Iowa report states that no trace of vegetation has as yet been observed in the widely distributed shales of this group, except a few traces of fucoids in the Utica slates of New York. This makes him doubt the vegetable origin of this bituminous matter. In this county, however, we have discovered fucoids woven all over the tops of some of the strata in this formation. May it not be that a condition of things similar to that in the Carboniferous eras, existed over the broad basin in which these shales were deposited? The vegetation consisted of the lowest orders, such as would decay and leave few traces of their existence. The disorganized remains would alone remain in the form of carbon or coaly shale. The day may come when this substance, whatever it is, will be of economic value, for light or even fuel. With this brief notice, we must dismiss for the present this very interesting question.

This formation is prolific of fossils. Countless remains, with an occasional perfect specimen of the splendid large trilobite, the *Asaphus gigas*, are the most noticeable. *Orthis occidentalis* and *O. testudinaria* abound. Some of these shales are covered with beautifully marked dendrites. Fucoids are also found. *Orthoceratites* and a large *Lituites* have been found in it, together with numerous other fossils.

The Niagara Limestone.—This is Owen's "pentamerus beds" of the Upper Magnesian limestone. It is next in order above the group just considered. The traveler on the Upper Mississippi must have been struck with its bold and picturesque appearance as he passed between Fulton City and Dubuque. Now the bluffs sweep down to the water's edge; now they trend off in a semi-circular direction, as if for the site of a colossal amphitheater. Their bases indicate the gentle slopes of the Cincinnati shales, but their summits are capped with the Niagara rocks. Like vast mural structures they rise along the highest elevations, weatherworn into all kinds of fantastic shapes—now displaying in their escarped cliffs resemblances to old forts and ruined cathedrals, time-worn castellated battlements, or distant spires and minarets of some old town. Such is the appearance of these rocks along the river bluffs above Savanna and towards the southern line of the county. The beholder, especially if he be a geologist, feels a strange spell stealing over him. Mighty visions of the old geologic ages enrapture his soul. A leaf from the old stone book is upturned before him, and he reads in the great Bible of Nature her sublime truths. He has discovered *hard sense*, common sense in the rocks.

But enough of dream and fancy sketching. Leaving the river, we do not find exposures of this limestone. Over the northern and northwestern portions of the county, all the highest portions are covered with it, in broken, fragmentary masses. Once it doubtless covered a large part of the county, but it has been denuded and carried off, leaving chert beds, corals and fragments of the rock itself as memorials of where it once existed as the surface rock. The frost, the rain and the atmosphere pulverize the Niagara rocks, and the chert beds in them being harder, settle down, like a crop of white flints sown over farm, field and hill. These chert beds show that the water of the old Niagara seas contained much silica in solution.

The Niagara limestone abounds in fossils. The most common and characteristic is the beautiful *Pentamerus oblongus*, or " petrified hickory nuts " of the miners. But the old Niagara seas were particularly the homes of the coral builders, and these minute animals swarmed in countless myriads everywhere, leaving their fossil monuments. Among the most characteristic are the *Favosites favosa*, *F. Niagarensis*; *Stromatopora concentrica*, *Halysites catenulatus*, and many other species and genera, containing, doubtless, new and undescribed corals.

This brings us through the Illinois rocks as developed in this county. Sometimes traces of the Trenton proper are found in the southern part, but they hardly deserve a place in the surface geology of Carroll county.

The rocks of all three of these formations possess value as building stone. The Galena ranks first, and the Cincinnati group last in economic value.

THE QUATERNARY SYSTEM.—*Alluvium.*—The Mississippi bottom, from Savanna to the south line of the county, in width averaging nearly five miles, is composed of this recent river deposit. The same deposit also exists north of Savanna, on the Mississippi, and along some of the small streams in the interior. Some of it is a rich, deep, black and rather wet soil; much of it consists of sandy deposits, while a portion forms our very best agricultural lands.

The loess or bluff formation does not exist to a great extent in Carroll county, unless the soil and sub-soil of our productive prairies belongs to this deposit. Some of our bluffs, as for instance where Johnson creek breaks through to the Mississippi bottom, are composed of the loess clays.

The drift formation is also manifest in our county to a considerable extent, although some seem to argue that it is undetected in the Galena lead basin. Deposits of drift, in our county, can be found resting immediately on the Galena rocks. All our little streams almost have cut down into deposits of boulders and gravel beds.

The following section, made in a well in the town of Mt. Carroll, might be taken as a fair type of the superficial deposit resting upon our rocks, beginning at the top and measuring downwards:

Black prairie mold	2	feet.
Yellow, fine-grained clay	13	"
Common blue clay	2	"
Reddish clay and gravel	15	"
Tough blue clay	2	"
Coarse, stratified gravel bed	3	"
Pure yellow sand bed	11	"
Black, mucky clay	5	"
	53	"

Another well, some three miles distant, passed through a second soil some fifteen feet below the surface, and immediately thereafter a deposition of timber or wood, two or three feet in thickness, many of the pieces having tenacity enough to hold together for months after exposure to the atmosphere. This well is on the farm of FELIX O'NEAL, and at the time of its opening was considered an object of much interest.

We cannot leave this part of our subject without again adverting to the boulders. For us they have a peculiar charm and interest. These "nigger heads," "hard heads," or lost rocks, abound in many places, where the streams and rains have carried the soils away. Oftentimes they are associated with gravel beds of the transported drift. Among them have been found several nuggets of copper, one of which was found lodged in a crevice of one of our Galena quarries. Some of these boulders are striated and furrowed by the glacier or the iceberg. Quartz, feldspar, granite, gneiss, hornblende, porphyry, syenite, and various combinations of these and other minerals, make up these traveled rocks.

Would that we could have the true history of one of these lost rocks—real old cosmopolitans in a primal world. What a wonderful interest would cling around its wanderings from the time when it left its home among the Plutonic rocks of Lake Superior, until some iceberg dropped it into its present bed, through gently moving currents towards the South-west. Ocean streams rolled these uncouth stones for ages at the bottom of the "vasty deep;" frozen into glaciers, they have been pushed along their snail-like pace; adhering to icebergs and ice fields and ice floes, they floated hither and thither through Northern seas, until the ice dissolved in the genial warmth. Could we know their true history, the "masquerade of the elements," the lost history of the world, would be made plain as a well-conned lesson.

The associated pieces of water-worn copper are "finger boards" telling from whence they both came, and the direction of the ocean currents which deposited our drift.

CHAPTER V.

WINNEBAGO COUNTY.

Winnebago county derives its name from a powerful tribe of Indians of that name, who once roamed over its fertile prairies, which then formed a part of their hunting grounds. It is bounded on the east by Boone county, on the south by Ogle county, on the west by Stephenson county, and on the north by the State line between the States of Wisconsin and Illinois. It is twenty-four miles wide from east to west, and twenty-two and one-half miles long on an average from north to south. It therefore contains about five hundred and forty sections of land. The townships, as named, are not all bounded by township lines, but in part by streams and imaginary lines, making the townships thus different in size and shape. Its general level is perhaps somewhat higher than that of Stephenson county, although we have no information of the actual figures. The face of the country is high, dry, somewhat more sandy, rolling, and undulating than Stephenson, with which we are now comparing it. A considerable portion of its surface is covered with timber of various qualities. In the north-western part of the county, along Sugar river and its tributaries, and along portions of the north bank of the Pecatonica there is much scattering timber and brush land, interspersed with occasional swampy tracts. A few miles below Rockford, along the north bank of Rock river and extending north and west from the same, there is a tract of barrens covered with brushwood and a rather light growth of white oak and black-jack timber. In the south-eastern portion of the county, along and near the Kishwaukee creeks, the face of the country is rough, hilly, barreny, brushy, and covered with an occasional growth of fair timber. The rest of the county is chiefly prairie, interspersed with many beautiful but small groves.

It is well watered with many fine streams. Rock river enters it about six miles from its north-east corner, at Beloit, runs nearly due south some eighteen miles to Rockford, then bears off gradually to the west and enters Ogle county some fifteen miles south and west of the latter city. This noble and beautiful stream, and its broad rich valley, fills the mind of the beholder with admiration. The waters of this stream are silvery and clear beyond any other river in the State; its bottom, for the most part, rocky and sandy, its current swift and strong, its flow and volume constant. Heavy water powers at Beloit, Rockton and Rockford afford splendid manufacturing facilities; and all along the stream, every few miles, dams might be constructed which would cause thousands of busy wheels to toil in the service of man. At these three places scores of founderies, factories, machine shops, manufacturing establishments, paper mills, grain mills and other similar enterprises, attest the capabilities and power of this magnificent river.

The next stream in size is the Pecatonica river. It enters the county on the west, some eight miles from its south-western corner, and flows in a general east and north course, about twenty miles, to near the town of Rockton, where it mingles its turbid waters with the bright, flashing currrent of Rock river. If possible, its course is more tortuous and its waters more muddy in Winnebago than in Stephenson county. Sugar river comes in from the north-west, and enters the Pecatonica near the village of Shirland. Both these streams have bottoms of rich, deep alluvium, from one to perhaps three miles wide. Neither of them afford any water-power. Both of them, we believe, are dammed in the water-mill sense of the term; but such lazy rivers will never make whirling wheels hum the songs of busy labor. The two branches of the Kishwaukee unite near the south-eastern corner of the county, and flow on, a considerable stream, until their commingled waters fall into Rock river, in the township of New Milford. Killbuck creek, in the south-east; Kent creek, coming in at Rockford; the Kinnikinick creeks, in the neighborhood of Roscoe; and another considerable stream, a tributary of Sugar river, in the north-west, are the most important of the smaller streams, and with their little feeding tributaries afford plenty of water for agricultural purposes, together with a number of light water-powers.

Some of the Indian names of these streams have a very descriptive significance. Pecatonica, as before-mentioned, means "crooked stream," or "muddy waters," and so far as the stream is descriptive of the name, it ought to mean them both. Sinissippi, the Indian name of Rock river, signifies "the rocky river." Kishwaukee means "clear waters," a name reasonably descriptive of the streams. Winnebago means "the fish eaters."

Taking, therefore, all things into consideration, Winnebago county is hardly so good a county for agricultural purposes as its western neighbor, Stephenson. The soil is hardly so fat; the amount of poor land is proportionally greater. But taking into account its manufacturing interests and facilities, the unexampled fertility and Rhine-like beauty of its Rock river valley, and the enterprise and wealth of its grove-besprinkled city of Rockford, it would puzzle a jury to decide which is the most desirable county.

Geological Formations.

The geology of Winnebago county is of the simplest character. First, there is the usual Quaternary deposits, consisting of sand, clays, gravels, boulders, subsoils and alluvium. After these, the three well known divisions of the Trenton limestone outcrops along the streams and hills, and show themselves in the railroad cuts, wells and quarries in different parts of the county. These are the Galena, Blue and Buff limestones of the Western Geologists. A perpendicular section, as near as we can construct it, exhibits the following strata:

Quaternary Deposits. Average depth about	15	feet.
Galena Limestone	96	"
Blue Limestone	35	"
Buff Limestone	45	"

The measurements of the limestones are made at actual worked outcrops. At no place could we discover the St. Peter's sandstone, although it must come well towards the surface about Beloit and Rockton. Neither could we discern remains of the Cincinnati group, although the thickness of the Galena would indicate that patches of it might exist. We believe, however, that the Trenton limestones are the only ones at any place exposed or dug into in the county.

Surface Geology.

Alluvial Deposits.—The usual alluvial bottoms exist along the Rock, Pecatonica, and Sugar rivers. These are from one to five miles wide. On the two latter the deposit is deep, black, fat, and rich, supporting in places a heavy growth of timber, and where cultivated affording the usual superior Indian corn land of flat river bottoms. The deposit along Rock river is not so rich, being composed more of sands and clays, with occasional patches and strips of the fatter soils.

Loess.—Some of the bluffs along Rock river are in part composed of loess clays, in which no fluvatile shells were noticed. This formation, however, is of quite limited extent.

The Drift Proper.—The drift, now the subject of grave discussion among the geologists, is very largely developed in Winnebago county. It is composed of loose detrital matter, often of considerable thickness, brought from long distances and deposited over large areas of the county. The materials making up this loose mass were not derived, to any great extent, from the underlying Trenton rocks, but came from the metamorphic regions of the north. Whether brought by the currents and flow of the waters, or transported adhering to the sides of those slow moving, pale green mountains, the ice-bergs; or ground and pushed and moved along by creeping, all-powerful glaciers, we shall never perhaps positively know. All of these causes may have contributed to these results, but the appearance of the gravel beds themselves indicate the long-continued action of water. This is much more evident in the Winnebago than in the Stephenson county gravel beds. The railroad track from Beloit to Caledonia, every few miles, cuts through the top of long undulating swells of land. These swells are pure, unmodified, unstratified drift. They are made up of assorted and well rounded gravel of all sizes, from that of a pistol bullet to that of a goose egg, intermingled with a white or yellowish-white sand, and occasional small boulders, and are sometimes ten or fifteen feet in thickness. All the railroads exhibit the same beds along their tracks, though in a a less marked degree. Every township in the county has more or less of these gravel beds, and their underlying associate deposits of clay and sand. Along some of the prairies, and in the little streams, huge boulders, the size of a haycock, are sometimes seen, partially sunk into the soil by their great weight. Two of these particularly attracted our attention. One was black as night, but bisected through the middle by a flame of flesh-colored granite three-fourths of an inch in thickness. We once saw one precisely like it, and evidently from the same locality, in Clark county, Missouri. The other was flame-colored and planed smooth on two sides, nearly at right-angles, evidently by glacial action. These lost or transported rocks, the story of whose journey from the north is wrapped in so deep mystery—clay and sand-banks, with faint lines of stratification in some instances, assorted gravel beds, nuggets and boulders of copper, rounded to smoothness by erosion of the waters; all these, left in their present positions, by the fingers of the retiring seas, slightly modified, in some cases, by subsequent agencies—make the study of the drift in this county attractive, and are full of lessons of thought to the contemplative mind.

A more particular description of the materials in these and similar gravel beds will be reserved until our report upon Ogle county is written.

The Trenton Formation.

The Galena Limestone.—Two-thirds of this county is underlaid by this rock. It is a heavy-bedded, yellowish, cream-colored, dolomitic limestone, compact, irregular, somewhat crystaline towards the middle and bottom strata, light-colored, porous, crumbling, and full of sand in little cavities toward the top. In some localities the bottom layers pass gradually into the blue shaly parts of the Blue division, so that it is difficult to place the line of demarcation between the two. An imaginary line entering the county about the southeast corner of the township of Roscoe, drawn thence in a south-east course until Rock river was reached; thence extended round in a slight bend towards the north-west, until within a short distance of the Pecatonica river, at a point about four miles west of its mouth; thence meandering along the Pecatonica from one to two miles south of the thread of that stream, until the western boundary line of the county was reached; thence starting south and keeping around the boundary line to the place of beginning, and embracing about two-thirds of the county, would indicate the superficial extent of this division, to which would have to be added a narrow strip, extending from the village of Pecatonica, up towards and nearly to the north-western corner of the county. The most notable quarries and outcrops within these boundaries were the following. The first heavy outcrop of the Galena limestone exposed on Rock river, after it flows upon the same, is about three miles above Rockford. A high bluff on the north bank of the river presents a bold escarpment, some seventy-five feet in highth. At this place a large quarry is opened. The stones are hard, compact, and subcrystaline, and burn into the very best quick lime. A little steamer, towing a couple of stone boats, makes daily trips in the summer season from this point to the perpetual New York lime-kiln in the city of Rockford, transporting thither the large quantities of stone daily burned into lime at this greedy stone-devouring kiln. Drifting down to the city we find the next heavy outcrops. One mile east of Rockford, along a prairie ridge, there is an exposure about forty feet thick, where a light colored, whitish, friable stone is quarried to a considerable extent. In the timber ridge, about one mile north of the fair grounds, is another, about ninety-six feet in thickness, where the workmen have penetrated entirely through the Galena limestone, and about five feet into the Blue limestone below it. The line of demarcation is strongly defined. No brick wall builded upon a stone foundation ever presented a more marked contrast. Three miles below the city, in a bluff on the west bank of the river, is a worked outcrop thirty-five feet thick. The bluffs here present a bold and picturesque front. Clambering vines festoon their face. A crown of timber sits along their brow. A narrow strip of greensward runs along their base, on which the shadows of some graceful elms delight to lie. The river, broad and many-voiced, goes careering by. There are few more refreshing spots than this, of a hot summer day, when the fierce sun is beating down on cliff and terrace, dusty road, and murmuring river.

Some half a dozen miles below this, and not far from the Ogle county line, is an exposure in the timber, about six feet deep. Thus the valley of Rock river, for two-thirds of its extent in Winnebago county, is hollowed out of the Galena limestone.

The Galena division of the Northwestern Railroad enters the county near the village of Pecatonica, on the west, and leaves it at the village of Cherry Valley, on the east line. In all its cuts and excavations it shows the lead-bearing rocks. It passes nearly over the center of that part of the county colored to represent them. At Cherry Valley a heavy quarry of these cream-colored limestones has been worked, out of which the massive stone for the railroad bridge and piers at this place were taken. Out of a crevice in this quarry several nuggets of pure copper were taken, the larger of which were sold to the tinners, or found their way into eastern museums. Between Rockford and Winnebago station there exist several light exposures, where excavations are made through the low hills.

Two miles and a half below Cherry Valley, down the Kishwaukee, is a lime kiln, where we found a man asleep, and all our hammering in the quarry did not wake him. A good lime is here burned out of the Galena. A mile further down, at Trink's quarry, an exposure of fifteen or twenty feet is laid bare, and many cords of stone have been taken away. In the bottom of this quarry we found a curious genius, boring away with a horse-power drill for a deposit of copper, on the faith of the witch hazel and some pieces of float copper, found, according to neighborhood tradition, in the quarry years ago. The Kishwaukees, before and after their confluence, cut into the Galena for their whole distance in the county, and all their hills and banks show its unworked and weather-stained outcrops.

One of the heaviest outcrops in the county is a little east of the station of Harlem, on the railroad leading from Rockford to Caledonia. The cut passes through a rocky hill, several hundred yards in length and about eighty feet in depth, at the comb of the elevation. A side track passes through the great ditch, on which cars are switched and left to be loaded. Derricks on either side lift the massive stones, and gently lower them on the cars. The strata here are massive and solid. They furnish splendid material for heavy railroad masonry, and many hands are kept constantly employed blasting them from their adamantine foundations. We know of no quarry in Northern Illinois so valuable as this for railroad purposes and convenience. The top of the hill is covered with a fine, limey, white clay. Gravel and boulders also abound in the neighborhood. About Winnebago, Argyle, and along south of Harrison, are many light quarries worked into the Galena. In fact, without further particularizing, all that part of the county bounded by our imaginary line circumscribing the Galena, is underlaid, at no great depth, by this famous lead-bearing rock.

The only fossil found in abundance, is the characteristic *Receptaculites sulcata.* The quarrymen and miners speak of it as the "honey comb," "sunflower coral," or "lead fossil." About Rockford specimens are exceedingly numerous, but generally break to pieces before finding their way into the cabinet, on account of the friable nature of the upper strata, in which they are mostly found. Judge MILLER has a specimen almost as round as an apple. This specimen, when we were in Rockford, was borrowed by an enthusiastic geologist, and we did not see it. But few other fossils were found.

The Blue Limestone.—The Blue limestone, or Trenton proper of the the older western geologists, next succeeds the Galena in the descending order. It is largely developed in the northern and north-western part of the county. It is here a thin-bedded, bluish-gray limestone, calcareous, or with a lime base—but some of the shaly partings have a clayey base. In the bottom of the deeper quarries, a very blue strata always exists. This is massive, and conchoidal or glassy in fracture, and in the mining region is known as the "glass rock." A line drawn from a point in the western boundary line of the county, some two or three miles north of where the Pecatonica river enters it, along the north edge of the alluvial bottom of this stream to a locality about midway between Shirland and Rockton; thence east of north to the northern boundary line of the county; thence west round the county line to the place of beginning, would bound the superficial area underlaid by this deposit, except that the extreme western part occasionally shows beds of passage into the overlying Galena, and except that a considerable patch of the Blue rocks exist in the extreme north-eastern part of the county.

The first and second railroad cuts, east of Shirland, made by the Western Union Railroad in excavating for their track, afford the best exposures examined for investigating the Blue limestones of the Trenton series. The first is about eight hundred feet long and thirty feet deep, the second is about four hundred and fifty feet long and fifteen feet deep. The rocks are of a whitish-gray color, with conchoidal fracture, becoming darker colored as the lower strata of the quarries are reached. Further west, about Durant, the stone shows a nearer approximation, in lithological characters, to the Galena. The elevations here are capped with the latter rock. The Sugar river hills are rock ribbed with the division of the Trenton, now under consideration.

The fossils noticed in the railroad cuts near Shirland, were so numerous as to make their description at this time too tedious. They were mostly small and fragmentary. Some of the thinner and more shaly strata are covered with shells, fragments of trilobites, stems of the encrinites, and pieces of corals, so thick as to resemble masses of fossils stuck together by some adhesive paste. The same limestones at Dixon are exactly similar in appearance.

The Buff Limestone.—This is an unevenly bedded, somewhat argillaceous or clayey dolomite. It is, for the most part, of a light-yellowish or brownish color, shading into blue towards the bottom of the quarries; is not very homogeneous in composition or stratification, presenting in some of its layers an earthy and in some a crystaline appearance. In every outcrop, worked to any considerable extent, the lower layers become quite massive, and of a dark-blue color. When first taken out this blue stone presents a beautiful appearance, and no materials make handsomer mason work; but when exposed to the weather for some length of time, the dark, rich, blue color fades into a dirty, whitish-blue, not so beautiful as the original color. This rock, however, makes a good building stone, but, on account of its earthy base, does not burn into a good lime. But a limited portion of the county is underlaid by this formation. If from two points in the boundary line between Wisconsin and Illinois, distant from Rock river on each side three or four miles, we extend two lines southward, following the general course of the river, but drawing gradually nearer together until a point in the center thread of the stream was reached, one or two miles south of the north line of Harlem township, the tongue of land thus inclosed would represent this portion. The chief outcrops of the formation, and in fact the only ones where it can be satisfactorily examined, are at Beloit, a short distance within the State of Wisconsin, and at Rockton, about the middle of our tongue-shaped strip of land. The quarry at this latter place is opened on the north face of a low range of hills, ranging along the south bank of Rock river, and distant one mile from the village. The outcrop, as here worked, is forty-five feet thick, and answers well to the above description, except that the upper ten or fifteen feet resemble beds of passage into the overlying division. This outcrop, together with its closely resembling ones at Beloit, in Wisconsin, and at Winslow, in Stephenson county, and at Martin's Mill, in Wisconsin, exhibits about the following section:

1.	Light colored, chocolate-brown clay, covered with a thin soil, full of large, unworn gravel, not apparently transported, but the undecomposed parts of shaly strata or layers formerly decayed or rotted into clays, about	5 feet
2.	Thin bedded, bluish-yellowish strata or layers, breaking with a more or less glassy fracture, and in some cases having a vitreous appearance, and in all cases resembling corresponding layers in the overlying limestone	15 feet
3.	A layer resembling the last, but heavier bedded and duller colors	6 feet
4.	One and sometimes two layers, separated by clayey shales and loose clays, of heavy bedded, massive, very blue limestone, with less conchoidal fracture than corresponding layer in Blue limestone	4 feet
5.	Heavy bedded, massive, dull sand colored limestone, very impure, breaks into irregular masses, and to the tongue has both a sandy and clayey taste	7 feet
6.	Clays, and clayey and sandy shales	3 feet

The upper part of all these outcrops, in our judgment, differs in but a slight degree from quarries in the Blue limestone of the same thickness. The lower part of the quarries, for four or five feet above and below the blue strata, has a more marked difference. But inasmuch as Professor WHITNEY, and other eminent geologists, class these quarries as the Buff limestone, and inasmuch as the types of characteristic fossils are somewhat different, we shall describe and map them in these reports as belonging to this division of the Trenton formation.

Fossils.—The characteristic fossils of the Buff limestone, observed at Rockton, consist of fragments and indistinct traces of fucoids: *Cephalopoda*, of the genus *Orthoceras*, *Cyrtoceras* and *Lituites*; *Gasteropoda*, of the genera *Pleurotomaria* and *Murchisonia*; *Brachiopoda*, of the genera *Orthis* and *Strophomena*; *Lamellibranchiata*, of the genera *Tellinomya* and *Ambonychia*; and zoophytes or corals in fragments.

The *Pleurotomaria subconica*, *Oncoceras pandion*, *Tellinomya cuneata*, *Ormoceras tenuifilum*, *Tellinomya ventricosa*, and species of *Orthocera* and *Ambonychia*, are the fossils occurring in the greatest abundance. The casts of some of these come out in great perfection.

Economical Geology.

Building Stone.—All three of the above described formations or divisions of the Trenton rocks furnish stone adapted for building and ordinary mason work. Especially is this true of the Galena limestone. The quarries at Harlem and Cherry Valley furnish excellent materials for solid and massive railroad masonry. The public school building in the city of Rockford is a model of architectural beauty, and solid imposing grandeur. No painter's art could improve its present rich, warm color. The beautiful cream colored residences scattered about the city, present an equally striking appearance. When dressed and laid up of equal thickness, nothing can excel the effect of these stone residences. We have heard much said of the beauty and aristocratic appearance of brown-stone fronts in other wealthy cities; but no stone ever quarried, unless it be the marbles or the flesh-colored granites, presents a more striking, solid, home-like appearance than these same cream colored limestones of the Forest City. When built up as these people know how to build them, they are an architectural miracle of stone and mortar. The rich, warm, soft, cream color attains its richest, warmest and softest hues in the stones taken from the Rockford quarries. It bathes them with a tint beautiful as Nature uses, when, with a brush of sunbeams, she lays her golden yellow upon the ripe ears of corn. And not only is the material beautiful, but it is lasting, seasoning when long exposed into almost the hardness of granite itself. Let wealthy builders hereafter, instead of sending for Milwaukee brick to put into their palatial residences, go to the rich outcrops of the Galena limestone, and dig from thence a building material every way more durable, more beautiful, and more simply grand.

The Buff and the Blue also furnish stone of good quality for all ordinary mason work, and it is easily 'quarried and easily worked. The dark blue strata, when handsomely dressed and laid up, either by itself, or alternating with the lighter colored, presents a picturesque and quaint appearance; but the colors are not fixed and fast like that of the Galena.

Lime.—The Buff limestone, of Rockton, will not burn a good quick-lime, but would doubtless, if properly managed, make a fair hydraulic lime. Some of the Blue limestones will make a fair quick-lime; but the Galena limestone excels all others in the quality of this useful material, which can be obtained in inexhaustible quantities from its convenient quarries. The New York perpetual patent lime kiln in the city of Rockford, before referred to, turns out thousands of bushels every summer month of an excellent building and whitewashing lime. It is a high structure, perhaps ten feet in diameter within its circular walls. Perpetual fires burn away at the bottom; the sinking, glowing mass is constantly replenished at the top with cart loads of stones the size of a man's fist; and daily from the lime pot below the hot, dusty, crumbly stones, soon to be transformed by the hissing touch of water into white floury lime, are shoveled into a convenient store house.

Sands and Clays.—Sands for all economical purposes are found almost anywhere along the river banks, or may be dug from thickly strewn drift deposits. Clay, to burn into a good common red brick, may be had in almost any of the underlying subsoils. The subsoil clays just above the soldiers' old camping grounds, a mile or two above Rockford, are of excellent quality for brick making purposes. While there last summer, a powerful compressing machine, called "The Little Giant," we believe, operated by a steam engine, was at work pressing dry dust into bricks solid enough to be handled. These, when burned, came out a beautiful cherry color, rivaling in appearance and richness of coloring the far-famed Philadelphia cherry-colored brick. If the experiment then being tried proves a success, another branch of manufacturing industry will be added to the many already possessed by this energetic little city.

Mineral wealth.—Of this the county possesses very little. Although covered to so large an extent by the real lead-bearing rocks, no bodies of mineral have ever been found in the county. Traces of lead are found in many of the worked exposures, and bits of float mineral are often picked up in the gravel beds; but these are simply matters of curiosity, and denote no workable bodies of the lead ore. The modes of occurrence of the galena or lead ore over the lead basin are very peculiar. A few well known centres of deposit exist. A radius of a few miles around these seems to be productive. All outside, even where the conditions would seem to be favorable, is unproductive.

Bog iron ore exists about many of the springs, but for economical purposes the deposit is worthless. Copper, in its pure state, is often met with. No deposit of the metal exists. It is all float material, found in connection with the drift, and comes originally from the Lake Superior copper deposits. A crevice in the Galena rocks at Cherry Valley had a considerable quantity of float copper deposited in it. It has all been removed. A railroad laborer found, in a gravel bed in the southeastern part of the county, a boulder or nugget weighing fourteen pounds. He sold it to a tinner, who shipped it to Chicago, and it found its way into the general copper trade. Hon. Anson S. Miller, of Rockford, has in his cabinet of minerals a handsome specimen of several pounds weight, found in digging a well some thirty feet below the surface. But all these are rather matters of interesting speculation, and are not of much economical value to the county.

Peat.—No peat beds of value were noticed in the examinations of this county. The land is too well drained to afford favorable conditions for the growth of this useful material. In the region of Sugar river, in the sloughs, swales and marshes there existing to a limited extent, and about the rise of some of the small streams south of Rock river, some small beds of imperfect peat and black muck doubtless do exist; but they will never be of value as a fuel, and are only adapted for use as a fertilizer of the soil.

Fruit.—Apples and pears of the hardy varieties succeed well, and more than enough for home consumption is raised. The garden fruits produce large crops. The somewhat sandy nature of the soil is well adapted to the strawberry. We saw, when there, patches of ground blushing red with this delicious fruit. The crop of leaves was not heavy, but the berries lay thick in tempting bunches over the ground.

Boys and women, with red stained hands, were gathering them into baskets for the Rockford market. Orchards planted in unexposed situations, or properly protected by timber belts, bear well, and the crop is remunerative and reasonably sure. Hardy vines, with winter protection, bear bountifully, and may be made a source of profit. The strawberry, currant, and gooseberry may be raised in great abundance without protection. The strawberry, however, does better with a covering of coarse straw during the winter, which need not be removed in the spring.

As to the grape growing and wine producing facilities of this part of the State, we refer those desirous of further information to our report upon Whiteside county, where the subject has received more attention from the horticulturists.

Indian Antiquities.

The Indian race is fading away before the resistless march of Anglo-Saxon civilization. At his present rapid decrease the Indian will soon be a historic man. But he has left memorials which will last when the proudest builded monuments of his all-conquering foes have crumbled into oblivion. The geography and significance of our Indian names is a very wonderful subject. Flint arrow points and spear heads are frequently picked up, while stone axes and smooth, oblong instruments, sharp at one end, and used for skinning animals, are of not unfrequent occurrence.

But the most common objects of interest to the antiquarian are the mounds, in common speech, thought to be of Indian origin. The mound builders, whoever they were, once swarmed in the valleys and woodlands, sat down upon every picturesque spot along the streams, and left their mound-builded structures as memorial monuments of their busy lives. We shall not in this place discuss their age or their origin, but simply describe some of the most prominent ones noticed in this county. They do not belong to its geology, but they are matters of great interest to thoughtful men. The antiquarian and archæologist, if not geologists, are laboring in a field close bordering upon the domain of that earth-delving science.

Three classes of these mounds were noticed and examined. There was the common round mound, from ten to fifteen feet in diameter, and from two and a half to five feet high. Mounds of this description are very numerous. There is a large group of them on the banks of Rock river, six or seven miles below Rockford. At many other places along this stream they exist in scattered groups. On the north bank of the river, within the city limits of Rockford, and a short distance above the bridge on Main street, several very large ones are preserved in the private grounds of citizens. But the locality where they are met with in the greatest numbers is on the banks of the Kishwaukee, in the southeastern part of the county, near the confluence of the two streams of that name. Scores of them are scattered about here, and scores more have been nearly obliterated by the sacriligious ploughshare of the white man. The oldest inhabitants recall many occasions where bands of Indians, pilgrim-like, returned to these silent mounds, and held over them for days their mystic pow-wows.

The oblong shaped mound is of much rarer occurrence. At the locality in Rockford already alluded to there is a very remarkable one. It is one hundred and thirty feet long, about twelve feet wide at the base, and three or four feet high.

Near by this one is a mound of the third class, or those having a fanciful resemblance to some form of animal life. In Rockford it is known as the "Turtle mound." But it resembles an aligator with his head cut off more than it does a turtle. We give its dimensions: Whole length, one hundred and fifty feet; width, opposite fore legs, fifty feet; width, opposite hind legs, thirty-nine feet; length of tail, from a point opposite hind legs to end of tail, one hundred and two feet; length, from a point opposite hind to a point opposite fore legs, thirty-three feet; distance from opposite fore legs to where neck should begin, fifteen feet.

These measurements were not made with exactness, but are simply paced-off guesses. The figure lies up and down the river, on a line almost north and south, the tail extending northward. The body rises into a mound as high as a standing man. The feet and tail gradually extend into the greensward, growing less distinct and indefinable, until they cannot be distinguished from the surrounding sod. The measurements across the body at the legs include those appendages, which are only a few feet long.

The effigy, whether of aligator, lizard, or turtle, seems to be headless, and no depression in the surrounding soil would indicate that the materials out of which it is constructed were obtained in its immediate vicinity.

It is a curious structure, and one would like to know its true history as he looks upon its partially defaced form. What were its uses, and who builded its uncouth animal proportions, may be better answered by the researches of the antiquarian than by the speculations of the geologist.

CHAPTER VI.

BOONE COUNTY.

This is, perhaps, the smallest county in the State, comprising only eight townships of land. It is twenty-four miles long from north to south, and twelve miles wide from east to west, and consequently contains only two hundred and eighty-eight square miles. It is situated in the north tier of counties of the State, a little east of the center of the same. Its boundaries are as follows: on the east, McHenry county; on the south, DeKalb county; on the west, Winnebago county; and on the north, the State of Wisconsin.

Its physical geography is not remarkable, and the general face of its surface not dissimilar to that of neighboring counties.

The townships of Spring and Flora, and in fact all that part of the county south of the Kishwaukee, may be called a treeless prairie, characterized by long, low, undulating rolls, and low ranges of hills and ridges. In some places it is flat, with swales and sloughs of limited extent, between moist marshes and black, fat meadow lands. A few trees skirt along Coon creek in the south-west, and scattered patches of timber in one or two other places relieve the level landscape. A broad, rich, comparatively level Illinois prairie, these hundred noble sections preserve yet some of that primitive beauty, which gave two townships their names. Before the busy teeming millions of the sons of toil swarmed over the fertile West, prairie flowers, in spring-like beauty and autumnal glory, bloomed, where now the glancing plow-share turns the spring furrow, and the golden-ripened wheat fields dally with the fugitive winds. The purple and golden clouds of flowers, that used to lay on these prairies, are now no more; but in their place the tasselled Indian corn waves its head, and men are growing rich from the cultivation in useful crops of these old flower-beds of nature.

But leaving these prairies, the county changes its appearance north of the Kishwaukee. It becomes rougher and more rolling. Although still good for agricultural purposes, the soil becomes thinner and lighter colored. More streams are met with. These are margined with hills to some extent, and hilly barrens. Wide stretches of rather light timber and brushwood extend for miles along the streams and over the intervening highlands. Here and there a grove of better timber may be seen. Small prairies, prairie openings, and long stretches of prairie still exist in every direction, but it soon becomes difficult to tell whether the rather poor timber or the irregular prairie land predominates, especially after passing nearly into the northern third of the county.

The same general remarks apply to this third of the county, except that considerable wet and swampy land is noticed. Many of the streams of the county take their origin in these low lands. The north-western part of the county has considerable prairie, and much wet land; the north-eastern has more timber, is higher and dryer, and on towards the "Big foot" prairie, in Wisconsin, contains good farming lands.

The timber consists mostly of black, white, burr, red, yellow, and some rarer varieties of the oak, black walnut and butternut, shell-bark and common hickory, cottonwood, sugar maple, honey locust, sycamore, water and slippery elm, haw, dogwood, common poplar, white and red ash, red cedar, white pine, linden or basswood, common swamp willow, and a few other shrubs and plants. Many of these are seldom met with, and indeed the groves in this part of the country are made up principally of the common black and white oaks to be met with in the poorer timbered regions of Northern Illinois. The alluvial lands skirting the larger streams are the only places where many of the above species of trees can be noticed at all.

Boone county, for the most part, is well watered. The Kishwaukee, here called a river, enters it on the east, not far from the center of the eastern line of the township of Bonus, and crosses in long, easy flowing curves, entering Winnebago at the village of Cherry Valley. It is a stream of considerable size, not very swift current, reasonably clear waters; and affords fair water powers at Cherry Valley and Belvidere. Coon creek comes in from the south-east, and falls into it near the center of the township of Bonus. This is the only tributary worth naming on the south side, within the county limits. On the north, the Piscasaw creek comes in almost exactly on the center of the eastern boundary line of the township of Boone, and flows in a south-west direction, until it is lost in the Kishwaukee at Belvidere. It is a light stream—too light for available water powers. Beaver creek comes in at the north-eastern corner of the county, flows in a direction west of south, and joins the Kishwaukee a short distance above the town of Cherry Valley. It is similar to the Piscasaw, and not valuable for water powers. Some small streams, in the township of Manchester, in the north-west part of the county, flow over towards Rock river, but they are small and insignificant. These water courses and their small tributaries abundantly water the county, and adapt it to stock raising and agricultural purposes.

Geological Formations.

The Cincinnati group and the upper division of the Trenton limestones are the only rocks which outcrop, or in any manner show themselves, in this county. About its north-western corner, extending to even some distance within its borders, the middle and lower Trenton limestones doubtless are the underlying rocks; but the ynowhere outcrop that I could notice. The deposits of the Quaternary system are extensive in the county, covering it over in many places to a great depth. It will thus be seen that the geological formations of Boone county are few, and its geology comparatively simple. The following section of the rocks exposed and the superficial deposits, is comparatively correct; although nothing but an approximation to the thickness of the latter can be given:

Section of Formations in Boone County.

Alluvium, principally partially stratified clays, sands and fine gravels, along the Kishwaukee, with loams and surface soils	20 feet.
Light colored, velvety, tough, tenacious, impervious potters' clay	30 "
Ordinary drift deposits, consisting of the usual sands, gravels, hard pan and clays	35 "
Cincinnati shales; the formation much deeper, but worked to a depth of	18 "
The Galena limestone, worked	35 "
Lower Trenton limestones	Unknown

Surface Geology.

The surface geology consists of the usual Quaternary deposits, except that the loess is perhaps entirely wanting. The alluvial deposits along the small streams are narrow, rich and black. On the Kishwaukee they are wider and deeper, intermingled with sands and fine gravels; and bear, in places, a heavy growth of bottom timber. The usual thin prairie soils, swamp mucks and peats of various degrees of purity and ripeness, make up the rest.

The drift proper is a heavy body of abraded and transported materials. Over that part of the county underlaid by the Cincinnati shales there is a thinner superficial deposit of a fine, laminated, comminuted clay, of a light ashy or blue color; bearing mingled evidence of deposition in still waters and the dissolving *in situ* of the underlying clayey shale rocks. No extensive gravel beds exist; but occasional large boulders may be noticed, more especially lying about the low springy places.

But leaving the gently rolling prairies, and going northward to the region underlaid by the Galena limestone, the reddish clays, hard-pan and coarse gravel beds of the upper members of the drift largely predominate. A few miles west of Capron are localities where boulders of the average size of a man's head, lay thickly strewn over the ground.

These were noticed to lie thickest where boggy and springy places were met with, surrounded by rougher and more rolling land. The boulders are all from the metamorphic regions of the north, and consist of granite, gneiss, hornblende, trap, and some other varieties, with their various combinations. Across the whole northern part of the county these boulders were noticed in a greater or less abundance, associated with clays and sometimes clayey sands. Across the central part of the county the coarse gravel beds, unstratified hard pan, and partially stratified clays make up the surface covering of the rocks. Under these, all over this region, laminated clays rest upon the indurated rocks below. Some of the gravel beds northwest of Caledonia are almost a mile long, and several feet deep. They are made up of materials very much rounded and abraided; are partially stratified; the gravel is of all sizes, intermingled with clean sand. A low drift hill of gravelly clay lies close to Belvidere, on which the court house stands. In the banks of the Kishwaukee, a short distance below the bridge between the north and south parts of the city, on the north side of the stream, are outcrops of the bank of tenacious potters' clay, before referred to. It runs under at least a part of the city, and in one place borings for some public work showed it to be some seventy feet in thickness. At another locality some workmen were sinking a well. After going through this deposit, which there was much thinner, water rushed into the well so fast that the men could hardly get out in safety.

In many places I heard of the traditional nuggets of copper that previously had been found among the gravel and boulders, but I could not succeed in finding any myself. Over this whole region, in connection with my observations upon the drift, I watched closely in order that I might detect indications of glacial action; but I am forced somewhat reluctantly to admit that atmospheric and chemical agencies and aqueous forces probably explain most of the phenomena connected with these superficial deposits. In the morraine-like hillocks of Ogle county glacial action, I think, is more manifest.

The Cincinnati Shales.—As already intimated, the shaly rocks of this deposit underly nearly all that part of the county south of the Kishwaukee. Coon creek doubtless cuts down to the Galena; but all the prairie ridges show the outcroppings of the former rocks, although worked exposures are rare. In fact there is but two good stone quarries in Boone county: one in the Cincinnati shales, five or six miles south of Belvidere, and one in the Galena limestone three or four miles northwest of the city. The former of these is opened in the brow of a low hill. A few feet of clay and subsoil is stripped from the surface of the shingly rocks. The formation is quarried into about eighteen feet in depth, and great quantities of stone have been removed and hauled for many miles over the surrounding country, and into the city of Belvidere. The quarry, or rather series of quarries, is a source of profit, not so much on account of the valuable properties of the stone, as on account of the ease with which they can be quarried and the scarceness of all kinds of stone in the county. We noticed here flagging stones twelve by twenty-one feet, and three or four inches thick, without an apparent crack.

On some parts of the rocky walls here exposed to the air, the "tooth of time" has made a marked impression. The rock is crumbling and decaying rapidly. Draw the finger over it and a shower of small fragments fall to the rocky floor.

About Garden Prairie, near the line between this and McHenry county, this formation is quarried and hauled north and north-west over the county for seven or eight miles, for purposes of ordinary stone masonry.

At no other places in the county is it worked. No natural outcrops exist, on account of the ease with which it disintegrates and covers up its natural outcrops; but it is not difficult to trace its boundaries by the gently undulating elevations, the marshy springs along their base, the color of the waters that trickle down the slopes, and the nature of the overlying clays themselves.

The formation here is unfossiliferous to a high degree. Nothing but a few indistinct tracings of fucoids or sea weeds were noticed.

The Galena Limestone.—Two-thirds of this county perhaps is underlaid by the lead-bearing rocks of the Trenton limestone. And yet in all this extent of superficial area there is but one good outcrop, and one place where the Galena is worked to any extent or advantage. This is at the exposure on Beaver creek, about three and a half miles north-west of Belvidere. Here the quarry is worked to the depth of thirty-five feet. The stone is massive and solid. Some of the bottom layers are from six to eight feet in thickness. Much stone has been quarried here for the construction of the railroad bridge at Belvidere and for building purposes in the surrounding country.

The country round the quarry is barrens and oak openings, with brushwood and a thin whitish soil. The upper strata of this outcrop are thin enough to be readily removed with pick and wedge and crowbar; but the lower ones can only be displaced by patient blasting.

I found here many of the characteristic fossils, such as *Receptaculites sulcata*, *Murchisonia gracilis*, *M. gigas*, *Pleurotomaria angulata*, *Ambonychia*, *Bellerophon*, and fragments of *Orthocera*.

Leaving this quarry, my examinations indicate that both Beaver creek and the Piscasaw, for their whole length in this county, are underlaid by the Galena limestone. From Belvidere, on a line east of north, through the townships of Bonus, Boone and Leroy, to Capron, and on nearly to the State line; thence west a few miles; thence south along the center township line of the county, through Shermanville, to the starting point; thence north-west to Caledonia, and a few miles north of the same; thence back on any convenient road to the starting point; thence west on the north Rockford road to the county line, and on all this extent of country gone over, I only saw indications of this limestone. Only a few imperfect, crumbly outcrops were seen in the faces of some of the little hills; not such as would pay to work.

On the Upper Beaver and round the feeding springs of one of the Kinnikinniks, some poor specimens of stone are quarried, such as are used for the foundations of houses about Capron and in that part of the county.

Blue Limestone.—On the map I have marked the north-western part of Boone county with the colors indicating the lower divisions of the Trenton formation. Its close proximity to Roscoe and Beloit, with some surface indications, lead me to believe that these would be the surface rocks, if the superincumbent clays were removed. No outcrops, however, were noticed, and the matter is of little general or economical interest.

Economical Geology.

Building Stone.—Building stones are scarce in Boone county. They are worth about five dollars per cord in the quarries, after being dug and prepared for loading.

The quarry on Beaver creek furnishes a solid, massive, hard stone, very suitable for bridge piers, culverts, and other railroad masonry, or any solid enduring masonic work. It requires, however, a good deal of labor to adapt it to the lighter kinds of masonry. The stone is in active demand, owing to the scarcity of other quarries in the surrounding country. Most of the heavy building stones used in Belvidere, such as church foundations and other like work, are obtained at this place.

The quarry in the Cincinnati shales south of Belvidere, already referred to, furnishes most of the stone used in that city for the lighter kinds of work, such as foundations for ordinary houses, ordinary cellar walls, walling wells, and light kinds of masonry generally. It also furnishes stone for a large extent of country over the surrounding prairies. The ease with which they can be quarried and broken into blocks of any required superficial area, makes them well adapted for these purposes. The layers are from two to four or five inches thick, and break with ease in any required direction.

In many places the Cincinnati shales are useless as a building stone, owing to the ease with which they disintegrate and crumble away. But here they seem to answer a fair purpose for the uses to which they are devoted. At Gen. HURLBUT'S residence, in Belvidere, we were shown some of them which had been in use twenty years, and yet they seemed little gnawed into by the tooth of time. For flagging stones they can be obtained of any desired size and shape, and where so used in Belvidere they seem to be answering quite well for this purpose.

We would not advise the use of stone from the Cincinnati group for solid work, or in structures which are to stand the test of ages. Some of it will season so far as to become enduring; but occasionally stones will be found, in the most carefully constructed work that can be built, which, after a few years' exposure to the rains and frosts, will begin to crumble and melt into their kindred clay.

Lime.—At the Galena quarry, above referred to, a lime kiln is in successful operation, and a good quality of common quick lime is burned. We believe, however, the city of Belvidere finds it more economical to use lime shipped on the railroad from other places. A good perpetual lime kiln at the Beaver creek quarry would furnish abundance of good lime, and would pay well.

Minerals.—No mineral wealth exists in the county. Bog iron ore in some of the bogs and marshes west of Capron was noticed in considerable abundance. Pieces of float copper are frequently picked up in the gravels of the drift. Traces of lead are sometimes found in the Galena limestone. Springs of chalybeate water exist in places. But all these are matters of curiosity and interest, rather than sources of economical value.

Sands and Clays.—From the ordinary clay and sand banks almost everywhere abounding in more or less purity, sand for building purposes, and clay for ordinary red brick, may be obtained in great abundance. The subsoil over most of the Galena rocks makes a good common brick.

The bed of potters' clay, before alluded to, deserves more than a passing notice. When ground and mixed with sand, it make a hard, handsome, cream-colored brick, quite as beautiful, and perhaps more enduring, than the far-famed Milwaukee brick. The front of the large new church in Belvidere is built of this material. For this purpose alone this bed of clay is valuable. And there is no reason why an article of common crockery might not be manufactured out of it in unlimited quantities. Even a queensware of fair quality might be made from this deposit.

When first dug the clay is tough and tenacious. The spade is forced into it with difficulty. The color is between a milk-white and chocolate brown. When dry it breaks with a somewhat conchoidal fracture; has a fat, unctious feel to the fingers, and becomes lighter in color. We do not know its chemical composition.

Peat.—In the township of Bonus, near the residence of a Mr. Chapman, and partly owned by him, is a peat bog of about twenty acres in extent. A Mr. Brown and Mr. Dana also own peat land in the same slough. Perhaps the bog contains in all forty acres. It is in a swale or slough running down into the Piscasaw creek in an east and west direction. It is susceptible of easy drainage. I spent some time in examining this peat bed. It was covered with a dense growth of sedgy grass; quaked and shook as we walked over it; had the usual carpet of the sphagnum mosses spread over its moist floor, and permitted us almost anywhere readily to force a common pole down seven or eight feet. The deposit is undoubtedly nine or ten feet thick in many places. The quality of the peat is a little fibrous. It is grass peat rather than moss peat, although grass and moss both enter into its composition. The bed is in a splendid formation stage; the peat is unripe peat. It might be successfully used as a fertilizer; but in the present stage of the peat experiment would hardly make a successful fuel. When properly prepared and condensed it will make a good fuel, and it will only be a few years, we hope, when peat machines will be brought to such perfection that this, and all equally good peat deposits, will become sources of material wealth and blessings to whole communities.

In the township of Manchester I also heard of the existence of peat of good quality, but did not succeed in finding the bed. Doubtless about the little feeding streams of the Kinnikinniks many beds of value exist, and will be brought to light when peat becomes of greater economical value.

Indian Antiquities.

The Kishwaukee was a favorite stream with the aboriginal inhabitants of this part of the country. No very conspicuous mounds were noticed, but the usual arrow points and stone implements are often picked up. Within a few feet of the northwest corner of the court house in Belvidere the spot is yet pointed out where "Big Thunder," a renowned Potawattamie chief, was buried. His grave was surrounded with ash palisades, the bottoms of which may yet be traced in the ground. He was buried in a sitting posture overlooking the beautiful plain to the west. He had prophesied that a final great battle would take place between his people and their pale faced enemies, in which the latter would be perfectly defeated; and he caused himself to be buried thus that he might view the bloody conflict, and with his voice of thunder cheer on his fierce warriors, as in life he was wont to cheer them. The first settlers speak of seeing his huge skeleton sitting in its place of sepulture, waiting in vain for the great battle. By-and-by his skull disappeared, and its disappearance became associated in the public mind with the visit of a wandering phrenologist. But the rolling years passed on. Bone by bone was spirited away. The palisades themselves mouldered into dust. The voice of the chief and prophet was forever stilled in death. The great Indian battle remains unfought. The seat of the Indian tribe is covered with a busy little city, and the plain is alive with the pale-faced race, and full of the roar of their industry.

Agriculture and Fruit Growing.

I would speak of the fruit-growing and agricultural capabilities of this county; but the remarks made in the geology of Winnebago county, upon these topics, apply to Boone county nearly as well as they do to that county, and we refer the reader to that report for remarks upon these subjects.

CHAPTER VII.

OGLE COUNTY.

This large and excellent county is bounded on the north by parts of Stephenson and Winnebago counties; on the east, by DeKalb county; on the south, by Lee county; and on the west by Carroll county, and a small portion of Whiteside county, just touching it on the south-west corner. It is thirty-nine miles from east to west, and about twenty-one miles from north to south, containing eighteen full townships of land, and about seven half townships. It, therefore, contains about seven hundred and seventy-three sections, or square miles.

Rock river, here a broad-flowing, swift, bubble-dancing stream, flows in a diagonal direction across the county, entering it about twelve miles from its north-east corner, and making its exit about eight miles east of its south-east corner. For most of this distance the stream sweeps along in long, undulating curves, except at Grand DeTour, where it doubles upon itself in short abrupt crooks. The river valley here is unlike itself further north and south. The face of the country along the river is abrupt, rough, broken and timbered. In only a few places do the prairie vistas open down to the water's edge, affording glimpses of the broad undulating plains, which open so wide beyond, that the blue of the sky and the green of the rolling sward seem to mingle in a far off blending. The little streams on either side have cut down through the hills, leaving bold outcrops of the Trenton limestones and St. Peter's sandstone.

To one familiar with the sublimity and grandeur of mountain scenery, as displayed in Alpine regions, or among the canons and wonders of our own Sierra Nevada or Rocky Mountain chains, where the slow-moving glacier creeps among eternal rocks down to the evergreen forests and the smiling valleys; where the mountain-born torrent leaps in foam along its rocky channel; where gorge and precipice and adamantine rocks, in wild confusion piled, fill the soul with awe—to one, I say, familiar with such scenes as these, the scenery along Rock river, in Ogle county, may seem tame; but to the inhabitant of the prairies, accustomed only to the grassy plains and green slopes of his native State, bedecked though they be in their native wildness with flowers of gayest hue, to him there is a charm in such scenery, as a ride along the river bank from Byron to Dixon discloses.

The resemblance to the old feudal castles of England, as, half-ruined, moss-covered and ivy-draped, they are preserved to us in picture galleries, is constant and recurring. The limestone bluffs, covered half way up their steep sides with the accumulated talus of ages, look like mural escarpments and Cyclopean walls among the wild hills. The sandstone cliffs of various hues, now glancing like snow hills in the sunshine, or glowing like hills of flame or yellow, when stained with the red oxide of iron, are weathered into all sorts of fantastic shapes. The rounded, tower-like, casemated masses, which stand out in bold relief at the Indian Pulpit, three or four miles below Oregon, and at other places along this heavy outcrop of the St. Peter's sandstone, need not the aid of imagination or fancy to shape themselves into dome and minaret, spire or cupola, or the graceful flutings, carvings, mouldings and columns of Gothic, Doric or Corinthian architecture. If well painted in oil, some of the more striking scenes would illustrate Illinois landscapes of no mean order of beauty.

These bold, perpendicular bluffs of rock and deep ravines cut into them by the little streams, afford excellent opportunities for an examination of the geology of this county, and will be again referred to in another part of this report.

At Oregon and Grand DeTour good dams are built across the river, and a part of the magnificent powers thus obtained are made available for milling and manufacturing purposes. Dams might be constructed at many other points on the river within this county, and a supply of water power be put into use, unlimited in extent. Indeed, such a stream as Rock river, for water powers, is hard to find; and some day it will enrich all this part of the State with its mills, manufactories, factories, founderies and machine shops. Other but smaller streams run through different parts of the county.

On the north side of Rock river, and tributary thereto, is Leaf river and Pine creek. The former rises about Adeline, and among the gravel hills in the north-west part of the county, and flowing in a south-east course, mingles its waters with those of the larger river, a few miles below Byron. It is a considerable stream, and affords some fair water powers for light work. Pine creek runs into Rock river a short distance below Grand DeTour. It comes down from the north, making a sweeping bend towards the east. It is not a large stream, but, geologically, is one of the most interesting water courses we ever examined.

On the south side of Rock river, the two streams of most note are Stillman's run and Kite river. The former is a small stream, rising in the eastern prairie townships, and terminating in Rock river, a mile or two above Byron. Those familiar with the history of the Black Hawk war need not be told that this stream took its name from the retreat of a detachment of white soldiers under Major Stillman, after it had been ambushed and defeated by a band of Black Hawk's warriors. Those slain in crossing the stream were buried on a high point of land, near the residence of Joshua White, Esq. So long as the little stream flows, its historic name will preserve the memory of that disgraceful scare and wild retreat from an almost imaginary danger. The latter is a more considerable body of water, originating mostly in the county, and coming in from a south-east direction. Its mouth is near the little village of Daysville. It is a slow, lazy stream.

The country is rough, and more or less rolling, in close proximity to all these streams, except Stillman's run. The rough, hilly part of the county, along the streams, is covered with a fair growth of the usual white and black oak timber. None of it could be called heavy timber, and some of it is brushy barrens. Still, all these streams, with a few isolated groves, furnish a fair supply for fuel and other economical uses. The timber soil is thin and white, but under proper cultivation, returns good crops of potatoes, fruit, cereal grains, and garden products. By far the largest portion of the county, however, is rich, undulating prairie land. All the eastern and south-eastern part, all the western and north-western part, together with much of the northern part, is prairie, as rich and beautiful as the State can produce. Whole townships are treeless. These prairies are covered with a soil composed of the fattest prairie loam. In a part of the State, where all the counties are prosperous, Ogle will rank among the foremost in agricultural resources, and in the elements of material wealth. The amount of farm products annually raised and sold are enormous, while the real resources of the soil are not yet half developed. When these resources shall be more fully developed, and the vast untouched water powers of Rock river and its tributaries shall be utilized, this county will attain a degree of prosperity which will place it foremost in that richest portion of the Prairie State, lying between Rock river and the Mississippi.

Geological Formations.

The geology of Ogle county is of a highly interesting character. Besides the usual surface deposits, the Galena, Blue and Buff limestones of the Trenton series, and the Cincinnati group, are all developed and outcrop; while the St. Peter's sandstone for about fourteen miles along the river rises in bold outcrops of from twenty-five to two hundred feet in thickness. The only other outcrops of this interesting formation in the Northern part of the State is at Starved Rock and Deer Park, on the Illinois river, and a few other points in LaSalle county.

The following section will show the measured outcrops. They are all thicker, perhaps, than these figures indicate, except the St. Peter's sandstone. The bottom of that formation and its full outcrop, we think, was reached. The floor of Rock river, three or four miles below Oregon, where its thickest development is reached, is the top of the Calciferous sandstone or Lower Magnesian limestone:

Section of Ogle county formations.

Usual surface deposits, consisting of sands, clays, soils and gravel beds, aggregate, perhaps	125	feet.
Cincinnati group, green and blue shales	25	"
Galena limestone	35	"
Blue Trenton limestone	44	"
Buff Trenton limestone	36	"
St. Peter's sandstone, white, soft	200	"
Lower Magnesian limestone	—	"

The above figures indicate the maximum thickness of the surface deposits, the St. Peter's sandstone, and perhaps the Buff limestone. The other members of the section I think are thicker than the above measurements indicate. Nowhere could I find exposures where the full thickness could be determined. Commencing at the top, we will describe these formations in their descending order.

Surface Geology.

The usual "river bottoms" exist along the streams to a limited extent. This, together with the common prairie soil, a vegetable mold, covering most of the county, comprises the extent of the alluvial deposits. The drift formation is much more heavily developed. Over the southern and eastern portion of the county, and along the lower Rock river bluffs, it thins out to a considerable extent; but over the northern and northwestern parts of the county the true drift, in the form of drift-hills and coarse gravel-beds, is very heavily deposited, reaching a thickness, as we have above indicated, of one hundred and twenty-five feet. Over the parts first mentioned fine-grained clay, sometimes marly and sometmes sandy, cover the nether rocks. These clays are almost uniformly of a light yellowish color. Few gravel beds and little coarse gravel can be noticed in passing over them. Boulders are of rarer occurrence than in any other portion of this part of the State. It is not a driftless region, but the drift forces have acted peacefully here, and nothing but the finer sediments and precipitates of the water were here deposited or accumulated under the action of chemical, atmospheric and aqueous agencies. But in the parts of the county last mentioned, vast accumulations of coarse gravel, commingled with fine white sand, have been deposited, indicating that the drift forces and agencies acted here on a large scale. Around the head-waters of Leaf river these gravel hills are a marked feature in the landscape. About three miles and a half north of Foreston, the Illinois Central Railroad passes through a range of these hills. The company have there opened many gravel pits and quarries, and are constantly loading trains for the purpose of ballasting their road. The appearance of that chain of hills is so remarkable that few travelers on the swiftly-flying passenger trains fail to notice and remark upon it. East of the track, a backbone of hills stretch away toward Adeline, broadening and widening in the distance, until they resemble great ocean waves fixed and solid. Our pocket-level showed that the highest hump on this backbone, measuring from the base, was about one hundred and three feet, while to the level of the water in the brooks some distance off, the descent was probably twenty feet. The railroad track is cut through these gravel hills to the depth of about forty feet. For that depth the material is composed of gravel, from the size of pebbles to that of small boulders, mixed with a large quantity of white sand. The sand is almost as white as the St. Peter's sandstone, except where stained yellow by the oxide of iron. The gravel is very much rounded and waterworn. The deposit has marks of partial stratification in a few places. At one place, close to railroad track, a bed of gravel, almost free from sand, is cemented so strongly together by some calcareous substance, that it has to be quarried like ordinary stone. It looks like a coarse conglomerate, or pudding stone, and will resist, without breaking, a smart blow from a heavy hammer. Such is the internal structure of these gravel hills. On the surface they are covered with a thin soil, full of gravel and whitish boulders of small size, into which a spade could not be sunk. Toward the east the hills preserve their outlines for a distance of some eight miles before they sink down into ordinary gravel beds, extending for a long distance across the northern part of the county. Toward the west they extend three or four miles before losing themselves in the general roll of the prairies. The direction of the main chain is exactly east and west; the western part, as indicated by a very good pocket compass, bears west southwest by east northeast.

A little brook runs toward the east on either side of the gravel hills, being, perhaps, a quarter to half a mile apart. About the middle of the range, the brook on the north side breaks through an abrupt gap, and joins its sister on the south, and together they seek Leaf river, skirting along the south side of the gravel beds. To the north and the south of the small valleys, through which these little streams flow, the prairie gradually rises until it attains almost the elevation of the gravel hills themselves.

These hills resemble strongly the central morraines of a vast glacier, or where two glaciers meet and mingle in one; but they also give evidences of the sifting and assorting agencies of water. They are, doubtless, "moraine hillocks," such as are found in many parts of Northern Wisconsin. If the surface of the underlying Trenton rocks could be examined, over a dozen miles in extent in this locality, they would, we think, in many places be found plowed, grooved and scratched, or planed smooth by the slow, silent force of the irresistable glacier or iceberg.

If the phenomena in this interesting locality indicate glacial action, and we think they most unmistakably do, it was probably combined with aqueous forces, and the two causes contributed to the results observed. We have sought for the manifestations of glacial action in many places, while examining the drift through these counties; but while evidences of the floating iceberg and ice-floe, with their freight of boulders, of peaceful atmospheric and strong aqueous forces are constant and recurring, this is the only locality where we could find phenomena that looked like the work of the glaciers.

I examined with care the materials of which these gravel beds are made up. Much of it is composed of metamorphic rocks, brought from the regions of Lake Superior. But a large portion, from one-third to one-half perhaps, is derived from the Niagara, Galena, and such other limestones as are found in the Lead Basin. They are much rounded and water-worn, but are not transported from the great distances from whence came the granites, syenites, and other boulders and gravels: *Tentaculites*, from the Niagara; fragments of *Orthocera* and *Orthis*, from the Blue; *Pleurotomarias* and pieces of *Trilobite* shields, from the Galena, were noticed among these piles of gravel—imperfect as fossils, of course, but sure indications of the neighboring formations from which they were derived.

A mixed mass of gravel, like the one under consideration, would seem to indicate that forces from a distance and forces near at hand, operating in every conceivable direction, with great force and over long periods of time, all contributed to gather together these heaps of abraided materials, some from the distant regions of the granite and the traps, and some from the neighboring limestones of a by-gone geological age; but all equally worn smooth by the grinding of the waters and ice.

But, leaving this interesting accumulation, we still find evidence of the drift gravels all over the northern part of the county; but the beds become comparatively thin, and are underlaid by the usual clays of this part of the State. The blue clays, belonging to the base of the drift, we failed to detect through Ogle county. It doubtless exists if proper excavations were made, but the common light-colored yellowish clay is by far the most common.

Remains of the *Mastodon* have been found closely connected with this formation. In 1858, the tooth of one of these animals was found in a little tributary of Stillman's run. The locality is low—somewhat marshy. The stream has cut a channel through the black alluvium of the low prairie. The tooth was washed out and lodged against a clump of willows when found. It is a ponderous grinder, weighs seven and one-half pounds, is covered with a black shining enamel, and is a fine fossil in a high state of preservation. The fortunate finder carefully preserves it, and cannot be induced to part with his treasure.

Other mastodon remains doubtless exist about the marshy springs of Stillman's run.

Some years ago a large bone, supposed to be from the fore leg of one of these animals, was found two or three miles above Byron. The bank of Rock river had caved down for some distance back from the stream; some five feet below the surface of the high land coming up to the river, and perhaps fifteen feet above ordinary water level, the bone was found sticking in the bank. The bank seems to be a sort of a modified drift, made up of somewhat marly, dark-colored alluvial clay, intermixed with river sand and a considerable quantity of gravel. The formation is hardly alluvium, but seems to be a kind of a river drift. The fossil is light, porous, and whitish in color, in a rather poor state of preservation. We obtained it through the courtesy of Mr. Mix, and sent it to the State Geological Cabinet.

Among the mineral substances found in the drift of this county, bits of lead and pieces of pure Lake Superior copper are occasionally met with.

The Cincinnati Group.

This formation is but lightly developed in Ogle county. No exposed out-crop, that we are aware of, exists at all. The high prairie, however, east and northeast of Polo, lying between Pine creek and the Illinois Central Railroad, and extending a few miles north towards Adeline, is underlaid by the shales of the Cincinnati group. At several recently dug wells, piles of these cream-colored and blue shales and clays attracted our attention. They are generally struck at a depth of fifteen or twenty feet, and soon crumble to pieces when exposed to the rains and frosts, and other atmospheric influences. The exact thickness of this group I am unable to state, but think it exceeds rather than falls below twenty-five feet. The area indicated is covered by the usual light-colred, finely comminuted clays, which nearly always rest upon the rocks of this group. It generally forms the subsoil of a good agricultural region, but sometimes it is inclined to be a little too sticky and wet. Ever-living wells of reasonably pure water are found without difficulty wherever the Cincinnati shales lie near the surface. In some cases, masses of sticks and decayed drift-wood lie between the shales and superimposed clays, separated from the former by only a few feet of marly, blackish clay. In such cases the water of the wells is neither sweet nor pure.

The Trenton Group.

The Galena Limestone.—Next in the descending series comes the upper division of the Trenton group, known generally in the books as the Galena limestone. It underlies a considerable portion of the county, emerging along the face of the ravines from beneath the concealing drift, and even rising like mural walls along some of the streams. The line of demarkation between this and the nether Blue limestone is not always easily distinguished. Layers, partaking of the characteristics of each of these divisions, are often found intermingled for some distance, although the characteristics of the mass of the two formations are very distinct. This peculiarity is not so marked in this county as in the eastern part of Stephenson.

The rock here usually preserves its usual coarse-grained porous nature towards the top of the quarries, changing into a denser sub-crystaline mass towards the bottom of the formation. It preserves its usual dull, greyish, cream-colored, chrome-yellow tints. No outcrop of it appears along the banks of Rock river, unless it may be near the Winnebago county line. But as we go back from the river, the older formations sink down and run under, and this becomes the prevailing surface rock.

It is an important member of the series of Illinois strata, both on account of its many economical uses, its historic interest, and the lead-bearing character of certain portions of its basin.

The superficial area underlaid by the Galena limestone in this county is quite large. South of Rock river the older formations come to the surface a few miles back from the stream, and outcrop along the ravines cut down into this belt of rough, rolling country. But the Galena runs on almost as soon as the level prairie is struck; and all the eastern and south-eastern townships are underlaid by it, and would show it, could the concealing drift clays be removed. The township of White Rock takes its name from a low outcrop of light-colored Galena about the headwaters of Stillman's run, near the center of the township. It is quarried to some extent, and hauled over the surrounding prairie. The stone is rather soft and crumbly, but is used extensively by the farmers for cellar walls, foundations and other similar uses. Killbuck creek running north through the south-eastern portion of the county, cuts into the same rock and even touches the Blue limestone, but no good outcrop is shown. About Payne's Point, in the township of Pine Rock, along a little timber ravine, stone are quarried, whose conchoidal fracture and ash color show beds of passage between the Galena and the Blue.

North of Rock river the same phenomenon is observed, only on a more extensive scale. The older formations sink as the distance from the stream increases, until the Galena runs on, forming surface rock where the river enters the county, but, before reaching Byron, it strikes these older formations. Leaf river and Pine creek cut deep into the surface deposits, and show outcrops of the St. Peter's sandstone, the Buff and Blue limestones respectively for some distance after the Galena becomes the underlying rock of the surrounding country; but even along the banks of these streams, the Galena outcrops long before their sources are reached. All round the headwaters of Leaf river the gravel beds rest directly upon the Galena limestone. The road from Polo to Mt. Morris crosses Pine creek about the middle of its course. At the crossing, Galena escarpments, crowned with the white pine and red cedar, overhang the creek as it washes their base. In going down stream the Blue Trenton is soon struck; but in going up stream, even to its very sources, massive time-worn outcrops of the real lead-bearing rocks add picturesqueness to the scenery. At the forks of Pine creek, a few miles north west of the residence of Hon. D. J. Pinckney, there is an outcrop thirty-six feet thick, the upper half of which is quarried into. A lime kiln is here in successful operation; and stone is quarried for common building purposes.

The western part of the county, between the Illinois Central Railroad track and county line, are principally underlaid by the limestone under consideration. Elkhorn creek, which just touches the county about Brookville, and Buffalo creek, a small stream west of Polo, both cut into the Blue limestone as the exceptions to the above statement. At the quarry one mile west of Polo, on the Mt. Carroll road, the Galena composes the top layers; the middle is beds of passage, and the bottom is the Trenton Blue. Following the creek down past the large Blue limestone quarries south-west of Polo, the Galena is again struck before the county line is reached, and at Sanfordsville, a short distance beyond the county line in Whiteside county, displays itself in a massive quarry, worked extensively in former days. The same rock prevails about Woosung.

At White Rock and at the forks of Pine creek a few characteristic fossils were to be seen; but the rock is not worked enough in this county to afford many fossils or good specimens. Where a Galena quarry is extensively worked for months at a time, and carefully examined during all its working, fossils worth gathering may be found; but a visit of a few hours to outcrops little worked at the time, cannot be very satisfactory so far as the acquisition of fossils is concerned.

The Blue Limestone.—This, the Blue limestone of the western geologists, or the Trenton limestone of the New York survey, is, under present classification, the Blue or Middle Division of the Trenton proper. In a descending order it next succeeds the Magnesian beds of the Galena division. It is variable in appearance. The upper parts of its outcrops are thin-bedded, almost shaly, and of a buff or lead-white color, often breaking into small fragments when quarried. The lower layers are compact and thick enough to make a good building stone. They break with a glassy fracture; and some of the layers near the bottom are of a deep ultra-marine blue color. This fine color fades a shade or two lighter when the stones have been quarried and exposed to the weather.

In the region of country underlaid by this rock, pit-holes, or sink-holes, are of frequent occurrence. These curious depressions in the face of the country are from one to three rods in diameter, and run to a point in a funnel-shape, at a depth of from six to fifteen or twenty feet. The rock also contains vertical crevices, through which subterranean streams of water often rush after heavy rains or springy thaws.

Along Buffalo creek west of Polo, for three or four miles, there is an upheaval of the Blue limestone. The top of the first quarry, the one on the Mt. Carroll road, as already stated, is composed of Galena limestone, shading down into beds of passage into the underlying division; but the bottom is the genuine blue "glass rock" of the Trenton. Two miles below this, on the creek, several other quarries are opened and heavily worked. They, and in fact all worked exposures of this rock examined in this county, show substantially the following section:

Chocolate-colored clays and subsoils, with fragments of rock and some gravel..................	5 feet.
Thin-bedded, buff-colored, fragmentary limestone, sometimes light lead-colored..................	14 "
Heavy-bedded, blue, glassy layers, breaking with cloudy, conchoidal fracture..................	6 "

These Polo quarries are worked to a depth of about twenty-five feet. The blue layers in the bottom are sometimes a foot thick. When lifted from their watery bed, they look as if dyed in blue ink. A large public school house is now building in Polo from stone obtained at this locality. The blue color is conspicuous, and the effect striking and beautiful.

This limestone also outcrops about Brookville and west of Foreston a short distance, where it is quarried on some of the small feeding streams of Elkhorn creek.

On the map of Ogle county I have marked, in colors, several long narrow strips on either side of Rock river. They extend diagonally nearly across the county, preserving the general course of the stream. The broad blue band represents the part of the county along the stream underlaid by the Blue limestone. All the small streams falling into Rock river from both sides, so far as I examined them, present the following succession of the rocks. At their mouths, especially from three miles above Oregon to Grand De Tour, the St. Peter's sandstone comes to the surface; a short distance up stream the Buff limestone outcrops along the banks and on the sides of the ravines; farther up, the limestone under consideration is met and continues to outcrop for two, three or four miles; then the Galena rises like a rocky wall along the waters' edge, and continues the surface rock until the headwaters of the streams are reached. Some of the hill sides show all three of these resting conformably upon each other, as in the ravines about Oregon, and along the lower part of Pine Creek. Kite river and the next stream below it south of Rock river, Leaf river, Pine creek, and almost any of the small brooks, present the same succession of the rocks.

On Pine creek, from a mile below the crossing of the highway leading directly east of Polo, to about Sharp's mill, the upper thin-bedded layers of the limestone under consideration outcrops in rocky faced abrupt bluffs, reaching a thickness of forty or fifty feet. The heavier blue layers of the Polo beds were not here observed. They resemble the outcrops of the same rocks above Dixon, except that fossils are rare, and the rocks have a dry, baked appearance. At Sharp's mill, the St. Peter's sandstone and the Buff limestone begin to outcrop along the base of the hills. Above Byron the river hills are capped with the Blue, changing into the Buff toward their bases.

The Blue limestone at Dixon and many other places is full of fossils. Slabs of thin stone are there found covered so thickly with fragments of small trilobites, corals, stems of encrinites, and mollusca of various genera and species, that one cannot help wondering at the great abundance of the lower forms of animal life, which swarmed in the ocean of the lower Silurian era. These thin fossiliferous strata are compact, and solid, and when dressed and polished look like a beautiful variegated marble. Dr. EVERETT, of Dixon, has in his cabinet specimens of this polished marble, which will compare in beauty with any marble we ever saw. In Ogle county, however, we could nowhere find in the Blue limestone the same abundance of fossils. At Polo, a large chambered shell known there as an *Ammonite*, but probably the *Lituites undatus* of Hall, is occasionally found; also an *Orthoceras*, which sometimes reached the great size of nine inches in diameter and eight or ten feet in length. But the thin fossiliferous layers, such as are found at Dixon, were not found. A heavier working of the outcrops along Pine creek, might disclose them. A barrenness of good fossils seems to characterize all the formations in Ogle county.

The Buff Limestone.—The lower division of the Trenton, or the Buff limestone of Owen, next succeeds in the descending order. It crops out in many places in close proximity to the St. Peter's sandstone. In some places it is separated from the overlaying division by a few feet of shale and blue clay; in others the transition from the one to the other is not easily distinguished. In the former, it is thick-bedded, compact, and the heavy layers are divided by thin fossiliferous layers and thin blue bands of clay; in the latter it is shaly, shingly, yellowish buff-colored, resembling much certain parts of the Blue division.

Dr. EVERETT's description of this rock corresponds with my own observations, so far as outcrops in close proximity to the St. Peter's sandstone were examined. In the ravines above and opposite Oregon; at Sharp's mill, on Pine creek; at Moore's quarry, in Lee county; on Kite river, and in one or two other places, this is true. At Sharp's mill and near Oregon, the lower layers are of a dull earthy color and fracture, with considerable sand in their composition, and on being struck with the hammer, give a heavy dead sound or thud, as if striking a mass of frozen earth.

This description would hardly apply, however, to the outcrop at Byron. This corresponds exactly with WHITNEY'S description of the Buff limestone outcrops at Winslow and Beloit; and these are exactly like many outcrops of the Blue division, except that the fossils do not seem to be identical.

Fossils.—At Moore's farm, in Lee county, many fossils were observed, mostly imperfect casts on the thin layers of shaly matter, separating the massive layers, and also on the surface of some of the massive layers. But in the Ogle county outcrops we could hardly detect a fossil, except at Byron. There we found a part of a large *Orthoceras*, six inches in diameter, perhaps. The animal to which it belonged must have been six or seven feet long.

The St. Peter's Sandstone.

This very interesting formation outcrops heavily in this county. It is the prevailing rock along Rock river, from about two and one-half miles above Oregon to three miles below Grand De Tour, a distance of about fifteen and one-half miles. Where the bluffs and high land come up to the river this rock nowhere outcrops more than a mile or two back from the stream. Even the river bluffs, along the sandstone region, in places, are capped by the limestones of the upper Blue and Buff. But up the tributary streams low outcrops may be noticed extending miles back from Rock river. Up Pine creek it may be traced as high as Sharp's mill, some five miles from the river. Up Kite river, for perhaps as great a distance, it shows itself along the base of the bluffs and hills, often just above the water's edge. Up the smaller streams it can be traced lesser distances. Many of these hills I have found capped with the Blue limestone lying upon the sandstone unconformably; many others exhibit the Buff and Blue lying upon each other conformably; some are capped by the Buff alone; some are nothing but hills of sandstone, uncapped by even the overlying drift, weathered into shapes resembling the pictured icebergs of the Arctic seas. The high bluffs, at the base of which the town of Oregon stands, with the exception of a light limestone cap on the top, are composed of light colored St. Peter's sandstone. At this locality it is about one hundred feet thick. It rapidly dips for two miles and a half up the river, and finally runs out of sight, the last outcrop observed being half a mile up a little stream, and about twelve feet thick. As we go down the river the thickness increases. About four miles below Oregon, at the fantastic shaped "Indian pulpit," the sandstone peaks rise higher than at Oregon, and before the mouth of Pine creek is reached the elevations measure from one hundred and seventy-five to two hundred feet. After reaching the mouth of Pine creek the formation dips rapidly and soon runs under the overlaying formations.

Two or three miles above Oregon, on the other side of Rock river, the bluffs rise in a long line along the stream to a hight of perhaps one hundred feet. The debris and talus of these hills present an abrupt, grass-covered slope, to within twenty feet of the top. The rest of the hight is a long, low, beetling mural escarpment of frowning Buff and Blue limestone. The talus covers the St. Peter's sandstone, which doubtless forms the base of the hills. Opposite Oregon, in a low hill, a sandstone quarry and a Buff limestone quarry exist within a few rods of each other.

Peculiarities noticed while examining this interesting sandstone suggest a few observations.

In many instances hard metallic-looking layers, or bands, like the red carnelian bands in the trappean rocks of Lake Superior in their modes of occurrence, are found running in somewhat parallel planes through the softer material of which this sand rock is composed. These are from one-half an inch to two inches in thickness, and are often within a few inches of each other. As the softer material crumbles away these remain projecting, giving the rocky face of the outcrop a pictured or horizontally veined appearance. The frost breaks these off, and they accumulate in the ravines. They give a hard and ringing sound when struck with the hammer, and almost resemble pieces of old castings in both color and hardness. These layers are ferruginous in texture, and were formed by the oxyd of iron cementing together and hardening thin layers of the sandstone while in course of being deposited. At a little ravine between Oregon and Mt. Morris they lay in piles, as if an old pot foundery had once existed there. At the crossing of a small stream between Dixon and Daysville, where an old mill-dam had once been built, and a low outcrop of red St. Peter's sandstone may be noticed at the right of the crossing, they lay over the hillside and in the road in great abundance. On many of them, ripple marks, as perfect as when made in the soft sand of the old Silurian beach, still exist. They are the eddies and ripples of the Silurian seas turned to fossils, and preserved in the embrace of iron and sand.

Again, these sandstone hills resist atmospheric agencies in a wonderful degree, considering the soft and friable nature of their composition. Oftentimes where they are most abrupt one can pick holes in their perpendicular sides with his knife, or strike his pick into the solid-looking mass. One would expect that such masses would crumble to pieces and sink into low, white sandbanks, but such is not the case. They preserve their forms as well as the limestones, and have quite as little debris and talus piled about their bases.

The color of this sandstone is of all shades, from the whiteness of crushed sugar to chrome yellow, and the many tints of brown and red. The color is a stain produced by the oxyd of iron held in solution in the waters, which have at various times percolated through the sandstone mass. Where this dye was absent in the percolating water a sandstone as white as granulated snow was the result; as the dye was present in the water, in that proportion are the sandstones colored and stained.

In consistence this sandstone is saccharoidal, or sugary, and much of it is held together by the slightest cohesive attraction. In many places, especially where the sandstone was very white, I found difficulty in obtaining cabinet specimens. Every blow of the hammer would shiver the block to pieces. But this is not always true. I saw houses built from this material which seemed to be hardening into a fair building stone; and Dr. EVERETT gives an account of an arched railroad bridge built over Franklin creek, in Lee county, from the same sandstone. In a few places it seems to have become hard and crystaline; in a few more it has cohesion enough to make an indifferent building stone; but its general character is soft, friable, and uncohesive.

Under a strong microscope the grains of the white variety appear limpid and semi-translucent; those of the darker varieties appear as if coated over by rust. All the grains are round, similarly formed, and similar in size. The grains are quite small, and the mass is remarkably pure and homogeneous in character. These incoherent, crystaline grains of transparent quartz owe their darker colors, where colored, to a solution of the coloring matter held in chemical combination; but in most cases the color is caused by a formation over the surface of the silicious grains of sand.

Distinct stratification exists in most of the outcrops, and even lines of cross stratification are not rare. WHITNEY failed to notice wave marks in the Wisconsin outcrops; but there can be no mistake as to the wave and ripple marks on the ferruginous layers of the Rock river outcrops. Some of the large masses present abrupt and strong dips; but these are owing to local causes. No trace of organic life, either plant or animal, has yet been observed in these sandstones. The era of their deposition seems to have been a peculiar one. Great changes must have taken place as it was ushered in and as it went out.

A high axis of elevation runs along this heavy deposit. In either direction from the river it dips away rapidly, and the overlying deposits come on in quick succession. Rock river runs along this anticlinal axis, having cut down almost or entirely through the formation.

The heaviest outcrop of the deposit now under consideration, in the whole area over which it is known, is the one along Rock river in Ogle county. The formation is thin and wide-extended, embracing a superficial extent in the northwest alone of more than four hundred miles in length by over a hundred in width. At Starved Rock, on the Illinois river, it is about one hundred and fifty feet thick. In Calhoun county it outcrops in the Cap-au-Gres Bluffs to a thickness of perhaps eighty feet. In Wisconsin and Minnesota its heaviest outcrops do not much exceed one hundred feet in thickness. In Ogle county, however, we think it reaches fully two hundred feet, and at the artesian well in Stephenson county it is perhaps considerably thicker. It is the identical same rock known in the Missouri Reports as the Saccaroidal sandstone, so extensively used in the manufacture of glass at Pittsburg. As observed in Missouri, however, it is oftener of a light buff or brown color, and has less of the white, pure silicious sand in its composition than the same rock has in Illinois and further north.

Geologists seem to be greatly in the dark as to the origin of this curious, interesting formation.

The Lower Magnesian Limestone.

The Lower Magnesian limestone, or Calciferous sandstone of the New York geologists, or its Western equivalent, comes, I think, to the surface at several places in the bed of Rock river, between Oregon and Grand DeTour. The floor of the river in many places along these high sandstone bluffs, I am quite sure, is a harder, solider, and altogether different rock. When doing field work in that part of the ground gone over by me, I had poor facilities for examining the river bed; but at one locality on the north bank of the stream, five or six miles below Oregon, and just at the edge of rather low water, I found a stratum of stone, apparently *in situ*, which I believe to have been the top of this formation. I confess, however, that my judgment as to the existence of the Lower Magnesian limestone along the river bed in this county is formed, at least partly, from analogy, appearances, and the natural belief that the bottom of the St. Peter's sandstone is here reached. A proper examination of the river bed, or some shallow borings along its shores, would satisfactorily test the matter, and settle any existing doubt.

Economical and Agricultural Geology.

Most of my remarks upon the economical and agricultural geology of counties north of this one would apply with equal correctness to Ogle. In physical features, geological formations, and agricultural capabilities, they have much in common. There are some points of difference, however.

Stone for Economical Uses.—All the limestones afford a good building stone. The seminary building at Mt. Morris, and the new public school at Polo, are fine examples of the building materials furnished by the Blue limestone quarries. The rock is not only strong, easily worked, convenient to obtain, but when properly laid up of blue, or mingled buff and blue colors, the architectural effect is beautiful. The thin-bedded top layers furnish a good stone for the lighter industrial uses. The heavy-bedded, dull colored buff is more used for the heavier kinds of masonry. The Galena in this county is a rough, thick-bedded stone, used in cellar walls, bridge foundations, and the common stone work necessary on the farms about its outcrops. In a few places the St. Peter's sandstone has crystaline layers of sufficient tenacity to cut into window and door caps, build into cellar walls and dwelling houses; and in one instance, at least, is used for the culverts in a small railroad bridge. It is easily hewn into shape, and seasons into greater hardness and tenacity.

Certain layers of the Blue limestone also burn an excellent common lime. The kilns above Dixon, in Lee county, turn out an abundance of as good lime for ordinary building purposes as need desired. be The sub-crystaline layers of the Galena are well adapted for lime production, and are much used for that purpose. On Pine creek, timber is abundant; stone from both these divisions is easily obtained, and of good quality; and lime can be made in any desired quantity.

It is generally believed that some layers of the Buff might be burned into a good hydraulic lime; but this is not known by the test of experiment.

Peat.—On the Killbuck creek, on section 30, in the township of Monroe, there is a long, narrow, irregularly shaped peat bed, containing about fifty acres. In the deepest parts the deposit is, perhaps, twelve feet thick. The peat is the result of the decay of the usual grasses, sedges and mosses, but is rather grass-peat than moss peat. Compared with the Cattail beds of Whiteside county, it is more porous, fibrous and unripe. It is available already as a fertilizer, and like the rest of our small, prairie, unripe beds, will some day be used largely for that purpose. Its value, as a fuel, depends upon the success of the peat experiments now being tried in many places. For a fuller discussion of Northern Illinois peat, its economical uses, its value, and its future prospects, I refer the reader to the report upon the economical geology of Whiteside county.

Clays and Sands.—Banks of common yellow sand, suitable for mortar making and plastering, may be found almost any where in the banks and sand-bars of Rock river. The sub-soil clays, under the thin oak soils, and in fact most of the sandy sub-soil, may be molded into a good article of common red brick.

According to all our Western geologists, the white rocks of the St. Peter's sandstone furnish the very best material for the manufacture of glassware. The Pittsburg glass manufactories obtain tons of their sand from the saccharoidal deposits of Missouri, a rock identical with our St. Peter's sandstone. Our sandstone, however, is white, pure, limpid, and free from foreign matter; theirs consist more of the yellow and brown-stained varieties. The sugary, white sandstone of the upper Mississippi is a pure silica. If the statements of the learned Dr. OWEN are true, only about two-tenths of one per cent. of extraneous matter, as shown by chemical analysis, enters into the composition of the snow-white sands of this formation.

Thousands of tons of the sand could be cheaply transported down the river to the Rock Island coal fields; or, when the contemplated railroad up the Rock river valley is completed, for the purpose of connecting the lumber regions of the north with the prairies of Iowa and coal fields of Illinois, the coal could be easily run up from Rock Island to the Oregon or Grand DeTour sand cliffs, and glassware for the whole Northwest be cheaply and successfully manufactured. These facilities for moving the coal and sand together will exist at no distant day. It will then remain for capital to invest in this remunerative branch of manufacturing industry.

Soils and their products.—The dark-colored loams are underlaid by a light-colored, clayey or gravelly sub-soil. The loam is largely composed of vegetable elements. If not made up of, it is at least greatly enriched by the successive growth and decay, for ages, of our common prairie grasses. This is the soil of our prairies. The timber soils are the usual clayey deposits of the oak ridges, underlaid by a close, compact, yellow sub-soil. Hungry, sandy soils are seldom met with. Leachy, loamy, fat soils, well adapted for the best farming lands, cover most of the county. The soils in this portion of the State are composed of silica, or the earth of flints; alumina, or fine impalpable clays; carbonate of lime, or calcareous materials, making marly soils; and various other materials, such as the oxyd of iron, organic matter, and the like. The two first are the basis of all our soils. The last gives them fertility. No soil is composed of a single one of these elements; but the mixture or chemical combination of all these, and sometimes many other elements, exist in the same soil, making clay soils, clay loams, loamy soils, sandy soils, vegetable molds, marly clays or sands, and many other kinds of soils, well known to agricultural chemistry.

I think the general proposition is true, that where large tracts of country are underlaid by the same or closely related geological formations, the soils will have some resemblance to those formations. They are undoubtedly, in part, derived from them; and in many cases in this part of the State, as I have already intimated, the soils and sub-soils seem to show their origin from these subjacent rocks. But this remark must be received with considerable allowance. The transporting, sorting, and sifting agency of water, the ice action of glaciers and icebergs, and the evidences that other geological forces have been at work all over this region, leads us to greatly modify the statement just made, and to believe that our soils are, in part at least, derived from many sources—some of them remote from their present localities. The same is true, I think, of the sub-soils, and finer materials of the drift. These, originally perhaps, were all alike; but chemical and atmospheric agencies and the growth of vegetation changed the surface clays into rich fat soils; the sub-soils received less of these influences, but still felt them, and were further changed by the percolating, saturating surface waters; but the deep lying clay and sandbeds received no change from these agencies. Even the acids of the air could not penetrate to them, and they remain unchanged.

Ogle county shows more evidences of a transported soil than western Stephenson or Carroll county.

Geology, engaged in investigating these phenomena, is thus the handmaiden of agriculture, and ought to be encouraged and studied by the farmer. He should not be slow to learn that all branches of human knowledge are bound together like the links of a chain; all the arts of life sustain to each other dependent relations, and all cultivators of soil or science ought to be bound together by the bonds of a common interest.

But, however derived or made up, the soils of this county are generous and fertile in a high degree. Indian corn, wheat, oats, hay, potatoes, barley, rye, the products of the kitchen garden, the hardier fruits of garden and orchard, are here raised in bountiful profusion. Vine culture has not yet attracted much attention, not for the want of suitable localities in which to try the experiment, but simply because attention has not yet been directed to this branch of horticultural industry.

In speaking of these noble soils—the Edens of agriculture in these Western States—I may as well make some remarks here, which apply with equal force to the agricultural policy of this and all the neighboring counties, and to the practices of prairie farming generally. I mean the unscientific, slovenly, and wasteful modes of cultivating the virgin soils of our broad prairies. The unripe peat and muck remain undisturbed in their beds; trenching and sub-soil plowing are never resorted to; annual fires consume the surplus stubble and stalks left from the last year's crop; ashes, bones, lime, the barn-yard and stable manures, if disturbed at all, are raked into some convenient out of the way place; and the farmer generally cultivates so much that he cannot half cultivate anything at all.

Geology and chemistry, and the experience of older countries, all cry out against this wrong done to our generous soils. In the first place, the farmer ought to study his soil, ascertain what element is wanting or what it has in excess, and intelligently supply the one or counteract the other. Instead of scratching over a large amount of soil, if he would go deeper and throw up a little sub soil, the kiss of the roving winds, the rain and the sunshine would enrich these, and his soil would grow deeper instead of becoming hungry and exhausted. Composts should yearly be made of every available substance, and scattered with a profuse hand over his meadows and grain-producing fields. Perhaps some water-soaked bog and some unproductive ridge, lying side by side, and both worthless, have in them the complements of the best producing soils, and only need a little mingling to make them the most valuable tracts in the field or on the farm. A little mind employed in cultivating the earth is better than much manual labor, aided though it be with all forms of labor-saving machinery.

Against this wasteful system of farming every industrial interest should cry out. Our soils, when new, used to return average crops of forty bushels to the acre; now fifteen is a good crop on the older cultivated lands. In the corn field, seventy, eighty, and one hundred bushels to the acre was not an unusual yield; now thirty-five or forty is oftener the exception than the rule. At this rate our land will rapidly become exhausted. Good husbandry, good farming, if not able to keep the soil up to its primitive fertility, ought, at least, to prevent its rapid deterioration.

CHAPTER VIII.

LEE COUNTY.

Lee county is bounded on the north by Ogle, on the east by DeKalb, on the south by LaSalle and Bureau, and on the west by Whiteside. It is a large county. Its longest extent from west to east is thirty-six miles, and from south to north is twenty-two miles. It contains eighteen full townships of land, and a little over four half townships, embracing in all about seven hundred and twenty-eight sections or square miles.

The face of the country is diversified, and is made up of rough, hilly land, broad and level prairies, and extensive swamps and marshes. The Winnebago swamps, in the south-west corner, and the Inlet swamps east of the center of the county, are peculiar features in its topography, and will receive a farther notice in a subsequent part of this report. The north-western part of the county, where Rock river cuts across the corner, is rough, hilly, and in places picturesque, especially in the vicinity of that stream. The hills and ravines in this locality are partially covered with dense underbrush and scattering timber. The rest of the county, with the exception of an occasional grove, is a broad, level, fertile prairie, inclining in some places to be rather low and wet. Such is the character of the prairie land in places in the eastern part of the county, and also along its western and south-western borders. The agricultural resources and grain-producing capabilities are very great, owing to the large amount of excellent farm land in the county, while the wet lands afford good grazing, pasture and meadow farms, and make stock raising a very successful and remunerative business.

Timber is scarce. Sugar Grove, Lee Center Grove, Melugin's Grove, Pawpaw Grove, and a few smaller groves, and the scattering bodies of timber along Rock river, afford about the only supply. The oaks, walnuts, sugar-maple, linden or basswood, and hickory are the prevailing kinds of timber, although almost every kind in the catalogues for northern Illinois may be found in the groves. Rock river and the railroads make the pine lumber of the north of easy access to the people of this county, and they do not feel this want of timber as do some of the neighboring counties. Hedges are also grown to a considerable extent, and dispense with much fencing lumber. The osage orange here makes an excellent fence when properly planted and taken care of. The history of this plant is peculiar. Many years ago it was extensively introduced in Northern Illinois. Miles of it were planted in hedges. There was great faith that it would prove an excellent fencing material, but the hedges were poorly planted and suffered to take care of themselves. As a natural consequence, poor cultivation and several hard winters caused the hedges to fail as fences. For several years the osage orange attracted little attention as a fencing material. But in course of time, a few hedges that had been properly cultivated grew into beautiful and successful fences, and public attention was again turned to the osage orange. Miles of excellent fence may now be seen in these northern counties, and hundreds of miles are planted every spring. Instead of the few rows of straggling, ragged, unevenly grown bushes which used to deform the landscape, long lines of well-grown, compact, green shining walls of hedge plants may now be seen, which would defy a buffalo to break through them.

Hedge-growing and timber-growing are not geological questions, but they are great material interests, which are now attracting much attention.

Rock and Green rivers, and the upper portion of Big Bureau creek, are the only streams of consequence in the county. All these flow in the same general direction, and almost parallel with each other. The general course of these streams is from north-east to south-west. Rock river strikes the county at Grand DeTour, about twelve miles east of the north-western corner of the same, and cuts off about two townships from the north-west corner. From Grand DeTour to Dixon the bluffs approach closely to the river, are bold, rocky, and precipitous, cut up with ravines, and show excellent outcrops of the several formations of Silurian rocks. Below Dixon the bluffs gradually recede and grow lower, and finally swell away into undulating prairies of great beauty and fertility. Green river is not a river, or even stream, for a portion of its course across the county. It takes its rise in the swampy land in the eastern part of the county, and in the Inlet swamps between the the eastern and central parts of the county. The surplus waters of this Inlet swamp, two or three miles south-east of Lee Center, are gathered into the first well defined stream or current of Green river. For ten or twelve miles the stream flows south westward, and again becomes lost in the interminable Winnebago swamps, in the south-west part of the county. Along its whole course there are no bold bluffs, no distinctive river valley, and no outcropping rocky formations, except about Lee Center, where some low outcrops of the Galena limestone are quarried.

Big Bureau creek, in the south-eastern part of the county, is a prairie brook, with no marked peculiarities.

Several small creeks and brooks, such as Sugar creek, in the township of Palmyra, and Franklin creek, east of Dixon, are worthy of notice. The latter is one of the most interesting little streams in the county. It exhibits in its short course a fine section of the geological formations in this part of the county.

Geological Formations.

These are varied and interesting. Below the superficial deposits, we commence with the Niagara limestone, and go all the way down to the St. Peter's sandstone. A section of the geological formations of the county, in the order of their sequence, would be represented by about the following figures:

1.	Drift deposits	10 to 75	feet.
2.	Niagara limestone	?	"
3.	Cincinnati group	30 ?	"
4.	Galena limestone	25 to 70	"
5.	Blue, or Old Trenton	20 " 75	"
6.	Buff limestone	18	"
7.	St. Peter's sandstone	150	"

Reversing this order, I propose to commence at the bottom, and describe these formations in the ascending order.

The St. Peter's Sandstone.—This very interesting rock underlies a very considerable portion of the county, and outcrops heavily on Rock river and Franklin creek. The heaviest outcrop in the county is opposite Grand DeTour, just across the river. The base of the bluff, for thirty or forty feet upwards, shows this rock. Here it has a solid, unstratified look, and rusty-brown color. On the Ogle county side of the river the sandstone is whiter, and the outcrop is over one hundred feet in thickness. For two or three miles the bluffs are mostly composed of this material. Just below the mouth of Pine creek, the formation on Rock river sinks rapidly out of sight, and is succeeded by the Trenton limestones. On the Lee county side of the river the sandstone soon disappears, after leaving the outcrop opposite Grand DeTour. Between this latter place and Dixon fine outcrops of Trenton limestone occur. The St. Peter's sandstone on Rock river, as will be seen by a reference to my report upon the geology of Ogle county, is chiefly developed in the latter county. For a distance of about fourteen miles, commencing about two miles above Oregon city and terminating a short distance below the mouth of Pine creek, it is a very marked feature of the Rock river bluffs. The outcrop extends back but a short distance from the bluffs. In some of the ravines and intersecting streams it can be traced for one, two, or three miles. On the east, north and west of these sandstone bluffs, the formation terminates abruptly, sinks out of sight rapidly, and seems like an abrupt anti-clinal axis pushed boldly up into the air. On these sides the overlaying formations are piled as it were against the sides of this sandstone uplift. But on the south side it sinks away more gradually, and doubtless is the underlaying rock for most of the distance in a south-east direction to the great upheaval at Deer Park and Starved Rock, on the Illinois river. A line drawn from the mouth of Franklin creek up that stream, thence on a south-east course to the south-east corner of Lee county, and thence to the Illinois river through La Salle county, for most or all of that distance, would pass over this deposit, lying almost or immediately under the drift deposits. A line from Oregon city to the same point, or lines from intermediate points on Rock river to the same point, would pass over formations almost identical. From the uplift on Rock river to that on the Illinois river, there is probably a low axis of elevation somewhere in the section of country bounded by the above imaginary lines. I have no doubt but that a broad strip of Lee county, extending from Grand DeTour to the north-west corner of La Salle county, is underlaid by the St. Peter's sandstone. About Franklin, and even south of that, this strip may be covered with fragmentary patches and fields of overlaying Silurian formations; but artesian wells for all this distance would soon strike the St. Peter's sandstone, after passing through the overlaying drift.

The next visible outcrops of this formation in Lee county, may be seen on Franklin creek. Several of these may be noticed, commencing about two miles below the village of Franklin, and showing themselves in the base of the creek bluffs all the way down to Rock river. The outcrops are low, and are sometimes capped by Buff and Trenton limestones.

These are the natural outcrops of the St. Peter's sandstone in Lee county. Along the northern line of the county, and east of Franklin creek for a few miles, other low-lying outcrops may exist. If so, I did not notice them; and they possess no peculiar interest,

This sandstone has often been described. Its varying shades of color, from white to dirty brown, rusty, and almost flame-red, are well known to all observers in its vicinity. Its want of cohesion, saccharoid, almost crumbling appearance, would seem to indicate that atmospheric and chemical agencies, such as the rain, the winds, the frost, and the tooth of time, would speedily level its piled-up sands and strew them far and wide; but this is contradicted by its remarkable property to weather into sugar-loaf shaped hills, ragged pinnacles, and gracefully rounded bluffs, able to preserve their form and shape through the rolling years.

Where unstained by the oxyd of iron, the grains of which it is made up are round and limpid in color, and are a pure quartz. The mystery of its deposition does not seem to be well understood. No fossils, no lines of stratification, have written on it and in it the story of its creation. Horizontal bands or layers, thin and dark iron colored, weather out on some of the outcrops, and give the same a pictured appearance, at a little distance. On the point of one hill a pile of these fragments lay, detached from the outcrop, resembling a pile of old, broken, iron pots. On some of these ferruginous fragments I noticed the ripple marks spoken of by Dr. EVERETT, of Dixon, in his description of this rock. These ripple and eddy marks sometimes resemble the forms of organic life in a remarkable degree.

Its uses will be spoken of under the head of the Economical Geology of the county. Ascending the scale we next come to the lower division of the Trenton.

The Buff Limestone.—Where *in situ* and fully developed, this limestone is separated from the St. Peter's sandstone by two or three feet of thin shales, intermingled with a blue and greenish laminated clay. This is especially observable in one or two of the Pine creek outcrops in Ogle county. The best outcrop perhaps in Lee county is in a ravine two or three miles east of Dixon, near the Oregon road. The outcrop is about half way down a hill sloping to the south. In the bottom of the ravine some large detached masses of the St. Peter's sandstone are laying in the bed of the little trickling stream. The top of this formation is probably just below them. The Buff outcrop above and in the hill-side, formerly quarried largely, shows a compact, heavy-bedded, crystaline or semi crystaline limestone. The massive layers are about a foot in thickness, and separated by thin fossiliferous shales and loose clay. These layers belong to the upper part of the division. The lower part, as examined *in situ* in Ogle county, is of a dull color, and gives out a dull earthy sound on being struck with the hammer, while these layers ring out a sharper and more metallic sound. Up Franklin creek in one or two places I detected the Buff limestone above and in close proximity to the underlaying sandstone. These are all the outcrops noticed in the county. This Buff limestone underlies but a limited area, and that in close proximity to the sandstone outcrops. The base of the bluffs, from the Blue limestone quarries above Dixon to the sandstone bluff opposite Grand De Tour, contain good sections of this rock; but the outcrops are deeply covered by the talus along the bluff line.

The Blue Limestone, or Trenton proper.—This is very heavily developed, both on Rock river and Franklin creek. About three miles and a half above Dixon, high, perpendicular outcrops begin to appear along the bluffs on the south side of the river; and from thence almost to the city limits of that city the bluffs are mostly composed of this rock. Extensive quarries and lime kilns are seen at many places in this distance. The greatest thickness developed along these quarries is from sixty to seventy-five feet. The small ravines leading down through the hill, show this rock in their channels, sometimes, for several miles. In these localities it resembles the white Hamilton limestone about Rock Island. North of Rock river its area is more circumscribed. Following up Franklin creek this rock soon shows itself in the hill-sides, even before the St. Peter's sandstone has disappeared below the surface. In one instance a detached sort of a tower rock stands in the valley of the small stream, entirely disconnected with the hills on either side. All the way up the rocky exposures may be seen. Near the village of Franklin, where the Dixon air line division of the North-western railroad crosses that stream, a series of large quarries, extensively worked in past years, line both sides of the creek banks for a considerable distance. A large hotel and other buildings in the village were constructed with the material taken from these quarries. Franklin grove, a fair sized body of timber, is underlaid by these beds, which outcrop in the creek. A section of Franklin creek would show the overlaying drift clays of varied thickness; about forty feet of this Blue limestone; and about twenty-five feet of the St. Peter's sandstone. These localities, and a few others in this part of the county, are the only places in the county where natural outcrops of the Blue or lower Trenton may be seen. In the south and south-western part of the county this rock may exist to a limited extent, but there are no natural outcrops, and it is hard to tell what formations lay under these level prairies.

Where best developed in Lee county, the Trenton limestone at the top of the quarries is thin-bedded, broken up, and of a light buff color. Towards the bottom the layers become heavier, intersected occasionally with upright clay seams; and in the bottom several massive layers of blue stone are found. On fresh fractures the color is a dark-blue; but it soon weathers to a bright sky-blue.

Some of the layers are full of fossils, the remains of organic life. When highly polished, these make a handsome marble, covered with the delicate tracings of the imbedded fossils and casts.

In many instances I noticed the "pot holes" spoken of by Dr. EVERETT, over the high surface of the country underlaid by this rock. They are a characteristic feature in the face of the country east of Dixon, and excite the curosity of the most superficial observer.

The Galena Limestone.—I prefer to retain this name in speaking of this member of the Trenton limestone. Descending Rock river from the locality of the Blue limestone quarries above Dixon, the Galena limestone is first noticed on the south side of the river, in the fine outcrop just above the Dixon mills. The rock has been quarried here, making room for buildings and to obtain building material, until it presents a perpendicular wall of stone, perhaps forty feet high. The top of this outcrop is real Galena limestone; the middle has somewhat changed in character; the bottom presents real beds of transition into the underlaying blue beds of the Trenton proper.

At Dement's quarry, one mile below this place, and on the north side of the river, and also in a hill at the north end of the Illinois Central railroad iron bridge, bold outcrops of massive, heavy-bedded, cream colored and yellow Galena limestone are largely worked. Thence down the river on the north side for about six miles, to Lawrence's quarry, almost every hill shows a Galena outcrop. Dement's quarry, and a bold stone bluff, projecting over the edge of the river current, about three miles below Dixon, each expose a thickness of nearly seventy-five feet of solid stone escarpment. In this distance there is one heavy exposure in the south bank of the river. At Lawrence's quarry the rock presents a sort of a metamorphic appearance; and some of the layers are covered with a white incrustation of carbonate of lime, resembling the frosting on a cake. From this last outcrop the banks of the river run low, and show no more rocks until the west line of the county is passed.

South of Rock river, along these Galena outcrops, the country spreads away in a dead level towards the Winnebago swamps. No rocky outcrops are seen, between this section of the river and the south line of the county; but this long parallellogram is probably underlaid by deep-laying Galena limestone, and patches of Cincinnati shales, which are shingled over it along the west line of the county.

North of Rock river the country rolls away in undulating prairie and sparsely wooded stretches, and is all, with the exception, perhaps, of a small corner below the mouth of Pine creek, underlaid by the Galena limestone. The physical features of the country show this at a glance. The Illinois Central railroad, in winding out of the low Rock river bluffs towards Woosung, makes several long but not deep cuts in the Galena limestone. Several wells in the township of Palmyra disclose it at their bottoms. Along the banks of a little prairie stream northwest of Sugar Grove, at a locality called the Big Springs, two or three excellent quarries are opened and extensively worked to supply the surrounding farms with building stone.

The outcrops of this formation south of Rock river are not numerous, but still a considerable area is underlaid by it. Commencing at Mount Carroll, in Carroll county, a low anti-clinal axis of the Galena limestone may be traced southeast through Milledgeville and Wilson's Mill to Rock river, just west of Dixon; thence on the same general course to Lee Center; thence bending south and west towards and near Sublette, and on to Lamoille in Bureau county. At Lee Center, in a grove of timber south-east of the village, there is a good exposure, where abundance of fine building stone is quarried. The stone is somewhat thin-bedded here. At Sublette, or its vicinity, there is another quarried exposure, and in north-eastern Bureau county, if I mistake not, some low outcrops exist. The Galena limestone also comes in from Ogle county in the north-east corner of Lee, and underlays two or three townships there, extending down perhaps to the head waters of Spring creek and the Inlet marshes. It is almost impossible to trace or bound the underlaying rocky formations in the level prairies of central and southern Lee county; but I feel quite sure the Galena limestone extends back for a considerable distance on either side of the anti-clinal axis above referred to, and so continues until it runs under the coal fields of Bureau county, or thins out and disappears from among the underlaying rocks.

An extended lithological description of this rock is hardly necessary in this place. It has been many times described in the reports of our Western geologists, and also in my reports upon Carroll, Stephenson and other counties in the northwestern part of the State. As developed in Lee county it is more massive and solid than in some localities further north, belonging as it does to the lower part of the formation. It has that rich, warm, cream color so characteristic of this stone.

The many economical uses to which this rock is put; its great thickness and local development, being only found in the lead basin of the Northwest; the rich stores of galena contained in its crevices and resulting clays, and the geological questions and phenomena suggested by an examination into its deposition and the origin of its metalic wealth, will always make it a very interesting member in the series of Illinois rocks. Neither is it devoid of organic remains, as will be seen when I come to notice the fossils characteristic of these Lee county formations. The casts of fossils therein entombed are of more than usual interest.

The Cincinnati Group.—No regular outcrops of this formation, I think, exist in the county. I have intimated, in speaking of the Galena limestone, that nearly all that part of the county north and west of Rock river is underlaid by that formation. This is not fully correct. Linn Grove, near Rock river, and almost on the western line of the county, and a small strip of land surrounding it, has a thin deposit of the peculiar shales and clays of this group underlaying the superficial deposits, and overlaying the Galena rocks. The materials excavated from wells in that vicinity show this.

In one other locality north of Rock river I suspect the existence of this formation. The base of "The Mounds," about two miles north and a little west of the west end of Sugar Grove, is composed, I think, of the shales and clays of this formation. There are no outcrops around these elevated and beautifully rounded hills. The gentle slopes leading up to their summits cover such outcrops with a talus, which has slowly accumulated around their bases.

South of Rock river a narrow strip of the Cincinnati group comes into the county a few miles south of its north-east corner, but soon thins out and disappears over the underlaying Galena. In the western part of the county, about and running south of the station of Nelson, on the railroad, fragmentary patches and a limited extent of that part of the county is likewise underlaid by the Cincinnati group.

The local extent of this formation being small, and there being no outcrops to attract attention, I do not deem it necessary to dwell further upon it.

These are all the formations developed upon Rock river in this county. In reviewing what I have said about them, it will be very evident that the geological position of Dixon, and the rocks developed in the short distance between Grand DeTour and the west line of the county, are of quite an interesting character. Geologists always spend the time occupied in their examination with interest and pleasure.

The Niagara Limestone.—"The Mounds," referred to above in speaking of the Cincinnati group, are capped, I think, with a light-bedded, broken-up Niagara limestone. The outcrop, however, rather suggests than shows this formation. All this portion of the country once undoubtedly was covered by the Niagara limestone underlaid by the Cincinnati shales and rocks. But these have been removed by denudation, leaving these mounds as conspicuous landmarks, standing upon the underlaying, level Galena limestone.

This is the only Niagara outcrop, such as it is, that I detected in the county. I suspect that a considerable area in the eastern part of the county is underlaid by this formation. A strip six or eight miles wide comes in from De Kalb county, about the middle of the eastern end, and extends westward nearly to the low land of the Inlet swamp, where it thins out and disappears. The only evidence of this is the existence of Niagara rocks in De Kalb county, in such a position as to favor this supposition. The general topography of the face of the country also makes this look probable.

The formation is not of sufficient importance in Lee county, either on account of its economical uses, its extent, or its geological interest, to call for a more extended description.

Fossil Remains.—Three of the above formations—the Buff, the Trenton, or Blue, and the Galena—are characterized by an abundance of fossil remains, in a very fine state of preservation.

The characteristic fossil of the Galena limestone is the *Receptaculites*

Oweni, or old *Coscinopora sulcata*, of the earlier geologists. In the common speech of the people it is known by various names, such as "lead fossil," "honey-comb," and "sunflower coral." A good specimen, with its central depression and folding-over edges, resembles the latter flower very much. In addition to this, of which good specimens have been found around Dixon, other casts of characteristic fossils are numerous, such as *Lingula quadrata; Murchisonia bellacincta; M. gracilis;* fragments of *Orthoceras; Ambonychia intermedia; Receptaculites globularis*, rare; *Chætetes petro-politanus*, very rare in this rock; *Calymene Blumenbachii*, rare; *Orthoceras anellum*, a species of *Cypricardites*, rather abundant; *Murchisonia bicincta; Illænus taurus*, rare; *Raphistoma lenticularis*, common; *Bellerophon platystoma*, common; *Ophileta Oweni*, common; *Illænus crassicauda*, fragments and shields common; *Trochonema umbilicata*, common; specimens of *Orthis, Ormoceras, and Maclurea*, rather common; a large species of *Columnaria*, rather rare; a species of *Petraia?* very abundant; and some other less common fossils, whose names I do not now recall.

In the Blue or Trenton, of the old Western geologists, fossils are so abundant that it would be tedious to enumerate them. In some of the thin, shaly, blue slabs found above Dixon, fragments of corals and stems of Encrinites, Trilobites, Leptaena, Strophomena, Orthis, and other shells and fragments are imbedded and stuck over them as close as they can be packed. A species of *Orthoceras*. some times attaining from six to eight inches in diameter, and from eight to ten feet long, is often found. Sections and fragments of this huge animal are of very frequent occurrence. A large chambered shell, probably the *Lituites undatus*, of Hall, is very characteristic. *Ormoceras tenuifilum; Gonioceras anceps; Orthis testudinaria; O. occidentalis; Strophomena alternata; S. filitexta; Leptæna sericea;* a new fossil named the *Vanuxemia Dixonensis*, by Meek and Worthen; and many others, too numerous to mention, are found in the outcrops along Rock river, in Lee county. The Trenton seas must have swarmed with these lower orders of life.

In the lower earthy and sandy layers of the Buff limestone I have not noticed many fossils. The Buff limestone, of Rockton, in Winnebago county, and of Winslow, in Stephenson county, is full of fossil remains—of species and genera almost identical with those found in the Trenton quarries at Dixon. The thick layers of the outcrop east of Dixon are separated by thin layers, an inch or two in thickness, abounding with fossils and impressions. The species here are not numerous, but the individuals are clustered together in multitudes. They are mostly casts of shells in a poor state of preservation. The *Lituites undatus* and the large *Orthoceras*, spoken of as found in the Trenton, are also characteristic of the Buff limestone.

The Silurian fauna, disclosed in the geological horizon represented by these Dixon formations, was truly wonderful. The soft mud of these Silurian seas became the sarcophagi of extinct species and generations. We tread reverently among these old stones, marked with forms of life now fossilized; for a great chapter of the history of the earth—of the story of creation—lies half revealed before us. The entombed relics of millions of years—cycles in which man had no part—Sibyline mysteries, almost too great for the finite mind to grasp—the story of undefinable epochs, written by the infinite finger of the Creator, in strong traces—these and kindred thoughts come over us, when gathering the fossils. No wonder Shakspeare could find "sermons in stones." The stones are full of sermons; full of an inspired revelation; they are the great Bible of Creation—the Stone Book, whose solid leaves are pictured over with sublime truths.

Surface Geology.

The surface geology of Lee county is also interesting. The drift beds, or gravel banks—the boulders or lost rocks—the clays and the sand—the alluvial deposits of the river and the swamps—these form instructive chapters in a subsequent ancient history of the county.

Alluvial Deposits.—Rock river spreads out into a bottom land of limited extent, below Grand DeTour. This bottom is composed partly of the Black river alluvium characteristic of river bottoms generally, and partly of banks and ridges of river sand; but before reaching Dixon the rocky bluffs on either side have drawn close to the river's shore, and for several miles below Dixon no alluvial deposits exist, except the shifting sand bars and gravel beds in the stream. Before leaving the county, the bottom again spreads out, and occasional small flat expanses are covered by crumbling, marly sands and clays more recent than the true drift. Even the extensive gravel beds worked by the railroad company, just below Nelson Depot, are river gravel beds belonging to this division of the Quaternary system.

The common prairie soil covering the county, composed largely of humus and the vegetable mold, left by the successive growths and decays of the prairie grasses, of course belongs to these recent deposits and is found all over the county. But the most marked of the recent deposits to be found in the county, are the swampy lands of the Green river bottoms. The struggle between water and land over these affords one of the finest illustrations of the origin and formation of the prairies to be met with in this part of the State. The land can almost be seen slowly encroaching upon the miry waters, and a real prairie taking the place of a water-logged swamp.

A large part of the township of Viola, and parts of the townships of Reynolds, Bradford and Lee Center, are taken up by the Inlet or Upper Green river swamps. This body of low land is about ten miles long, and from two to five miles wide. It is mostly covered with a dense prairie grass, among whose roots is concealed, in the wet seasons of the year, a thin sheet of water. Towards its center the water is deeper, and patches of cat-tails and rushes abound. On the south, the country slopes up gradually to the water's bed between this stream and Bureau creek; on the north, to the dividing ridge between Green and Rock rivers. The southern slope is sandy prairie; the northern is a rich, productive one. The soil in the swamp is a black, miry muck, carpeted with a prairie sod strong enough to bear the fowler's tread. The dryer portions of these swamps afford unlimited quantities of coarse prairie hay, much used in wintering stock. They also afford grazing for large droves of cattle in the summer season.

The Winnebago swamps are even larger than the Inlet swamps, and have about them several new features. Hills of almost indurated sand rise in chains and clusters and groups from the midst of some of the swamps. These sand mounds and sand dunes were originally heaped up by the winds from materials brought from neighboring sand ridges, or at least partially formed in this way. Some of them are forty or fifty feet high, and are covered with scattering but stunted trees. The sloughs and swamps wind through them in many places, dark bands of green vegetation and glancing patches of water amid sand deserts and oak barrens. The intervening swamps are fringed with a band of thick growing swamp grass, on a miry, mucky soil; then comes an inner fringe of dense, cane-like rushes and cat-tails, growing so thick and tall that it is almost impossible to penetrate it; then comes stretches of clear water, with hard sand bottoms, over which one can wade easily without miring. No habitations are near these watery jungles. A spirit of desolation seems to brood over them. The tall, purple-caned reeds bend their light feathery tops in the wind; triangular-shaped rushes cut the bare legs of the wader with their sickle edges. Innumerable water fowls congregate here in the spring and fall months, and the evening and morning hours witness a babel of bird voices, nowhere else to be heard to an equal extent in the State; and when the adventurous duck-hunter discharges his gun, the roar of myriads of wings, and an uprising cloud of the whole web-footed tribe, disclose the fact that even these desolate spots have their uses.

Of course this description of the Winnebago swamps applies to only a part of them. The rest are similar to the Inlet swamps, being more grassy and less wild. Some of these statements may not seem like the utterances of practical science. They are true, nevertheless. I have spoken of them at some length, because they are very marked features in the surface geology of part of this and the adjoining counties, and are known as remarkable places over all this part of the State.

The Drift proper.—This county is covered with the usual drift clays of this part of the State. If these superficial deposits were stripped off, the surface of the underlaying rocky formations would probably present quite as level an appearance as the present face of the county. The depth of these drift clays is hard to ascertain, being quite variable. Over the township of Palmyra wells are put down from thirty to fifty feet before striking the rock. One of these wells gave the following section, as given to me by the person who dug it:

1.	Black mold and subsoil	6 feet.
2.	Finely comminuted buff-yellow clay	12 "
3.	Blue, compact, laminated clay	10 "
4.	Black, oozy, marly mud, full of sticks, etc.	5 "

At this point an abundance of rather brackish and not very sweet and pure water was struck, and the well up to the present time is never failing, and the water growing sweeter and purer. At other localities in this township wells are put down to the rock, and then drilled fifty or sixty feet in the Galena formation below, before water is found.

Over the southern part of the county the drift clays are probably thicker than in the vicinity of Rock river. Where thickest, the blue clay is usually much the heaviest deposit, and is often underlaid by the black mud of the above section, No. 5, or by a bed of gravel and dirt of variable thickness. In the eastern and central portions of the county beds of sand often cover the surface and alternate with the clays below the surface.

This blue clay and the black deposit containing the decayed remains of timber, and the gravel beds on which the blue clay often rests, lies at and near the base of the true drift in this part of the State. Clay deposits covered the Silurian rocks before the drift forces acted. These deposits were then undoubtedly very much thinner than now, and were derived from the slow decomposition of the underlaying rocks and partook of their characters. The ice and waters of the drift period, the transporting, grinding and abraiding agencies then acting with so much power, increased these deposits very greatly; mingled them up; assorted them, and left them in their present forms as beds of sand, different colored clays, gravel and boulder beds, and other deposits as we now find them, modified somewhat by subsequent surface influences. Since the drift epoch there has been a constant struggle, with varying results, between the ravines and the level lands. Rains and water currents constantly struggle to cut out ravines in the crumbling clays, Rains and other atmospheric agencies constantly struggle to fill up these ravines, and reduce the surface of the ground to a water level. These forces, thus acting in antagonism, nearly balance each other in their effects, and keep the general face of the country about the same.

No extensive gravel beds of the drift period were noticed in Lee county. Occasional nuggets of copper and galena are picked up in the surface clays and ravines. Scattering boulders are also often noticed in the ravines about Rock river and lying on the surface of the prairies even in the region of the swampy land. One remarkable flame-colored boulder, of several tons weight, lies on the side of the road a few miles south-east of Dixon; another, of still deeper color, lies two or three miles east of Dixon. Either of them would attract the attention of the most casual observer, and he would find himself wondering as to their history and origin.

Economical Geology.

Building Stone.—Plenty of good building stone is quarried in the outcrops of Trenton and Galena limestone along Rock river. These supply the country for some distance away from the river. The Galena quarry at Big Springs is extensively worked; so is the one directly south-east of Lee Center. In the vicinity of Franklin the Trenton outcrop along the creek of the same name has been extensively worked, and the materials thus obtained used over the surrounding country and in the village for building and farm purposes. The sandstones of the St. Peter's formation in some of the outcrops of Franklin creek are hard enough to be handled and hewn into shape, and are used to some extent for ordinary mason work. An old culvert bridge one mile west of Franklin is built out of this rock. In Ogle county, just across the line from Lee, we noticed one or two houses built of this material. But the rock is hardly hard enough to be handled well, and makes poor stone work.

The Trenton limestone, for rough, ordinary mason work, furnishes a good material. It is very lasting, but very difficult to make handsome work out of. The large mills at Dixon are mostly built out of this limestone; so are the buildings for some large manufacturing establishments located at Dixon. The stone is so easily quarried and so readily obtained, that it has added much to the building facilities of the city of Dixon.

The Galena limestone, for heavy masonry, such as culverts, piers and the like, is the best in the county. The city of Dixon is now engaged (1868) in constructing a splendid iron bridge across Rock river to unite its north and south divisions. Two heavy abutments and a number of high, solid, and heavy piers were necessary to support the great weight of iron in the structure, and`to resist the crushing weight of ice, which sometimes impinges against them in the spring floods. After an unsuccessful attempt to contract for Joliet or Athens limestone, the persons having the work in charge made arrangements to build the heavy work necessary to be constructed out of the layers of massive Galena near the city. To this end Dement's quarry, about a mile north-west of the bridge, has been heavily worked during the past summer. Massive stones have been quarried in great quantities and dressed into proper shape. The result is highly satisfactory. It would be hard to find mason work anywhere which, for warmth and softness of color, massive strength, and the quality to season harder as the work grows older, can excel that now being completed for the iron bridge at Dixon. Not only does this stone answer well for marine masonry, but for building private residences, whether dressed or bush-hammered, it is all that could be desired. For foundations, wells, and the many other uses for which a stone is required, it also answers well.

Lime.—Both the Trenton and Galena limestone burn into an excellent article of common lime. The kilns below Dixon, along the Trenton outcrops, some years ago seemed to prefer this latter limestone. At that time and now they turned out a good article of this very necessary material. But at the present time the quarry near the mills in Dixon seems to be preferred, and a large kiln here is in constant operation. The top of the quarry is mostly used at the present time. The quarrymen take up the stone nearly on a level with the top of the kiln. This is a compact limestone and makes both a strong and a white lime. The lower layers, the harder, subcrystaline layers between the Galena in the top and the Trenton in the bottom of the quarry, a sort of transition rock between the two, are equally good for the same purpose.

Great quantities of lime can here be easily manufactured. It might be produced for the home market and for shipment, and ought to become a source of material wealth, and one of the elements of the city's prosperity. Coal, lime, and clay for brick and pottery-ware, are great resources for the production of wealth and the enlargement of human happiness.

Common Clays and Sands.—These exist in abundance in every part of the county. From them a good article of common red brick and mortar for building purposes may be obtained. Fine gravel exists in the bed and banks of Rock river, and can easily be obtained in any quantity desired for economical purposes.

Other deposits.—The softer and whiter limpid quartz sands obtained from the St. Peter's sandstone would furnish a good glass sand, and will be in demand some day for such uses. The subcrystaline strata of the Buff limestone would probably burn into a fair hydraulic lime; and if so, would add materially to the resources of the county.

Plenty of muck beds and half formed peat deposits of mud exist in the sloughs and swamps. These might be made valuable as fertilizers and amendments to the soil; but in the present state of prairie agriculture they are not in demand for this purpose. Good beds of peat ought to, and do probably exist in the swamps; but none fit to work have attracted attention, so far as I know.

Nuggets of copper are found in the drift clay, but are rather matters of curiosity than of economical value. Pieces of galena have been found in the rocks in the north-western part of the county; but no valuable deposits of this metal probably exist in the Galena rocks of Lee county.

The agricultural and horticultural resources of the county are about the same as those of the surrounding counties, and have been fully described in the reports upon some of these counties.

CHAPTER IX.

WHITESIDE COUNTY.

The geology and physical geography of Whiteside county are of a most interesting character.

The county is bounded on the north by Carroll county; on the east by Lee county, except the north-east corner, which is touched by Ogle county; on the south by parts of Bureau and McHenry counties; and on the west by Rock Island county, the Mississippi river, and the Marais d'Ogee slough. It is twenty-four miles long from north to south, and about thirty-two miles wide from east to west. It contains sixteen full townships, and four parts of townships on the western side. The number of square miles or sections of land embraced in all these is about six hundred and seventy-six.

The surface of the country is greatly diversified. The northern, north-eastern, eastern, central, and south eastern parts are chiefly composed of high, level, rich prairie land, as well adapted for agricultural purposes as any of our north-western prairie lands. That part south of Rock river, except a strip west of Prophetstown; that part along the Marais d'Ogee slough on the west and south-west; the region of the Cat tail slough, opening above into the broad Mississippi botton, and below into the Rock creek bottoms—these parts are level, low, and characterized by marshy, swampy, grass covered sloughs and boggy and broad expanses of wet lands. In some of the western townships sand prairies of hungry, poor soil exist. The same may also be seen along portions of Rock river.

Along the western bluffs, and through the township of Ustick, the surface is rough and covered with oak barrens. An alluvial band of heavy timber fringes the lower part of Rock river. The high prairies are diversified with a number of beautiful groves. Among these, Genesee grove, Union grove, Round grove, and Kingsley's grove are the most conspicuous. Rock creek, Elkhorn creek, and Buffalo creek have more or less timber, thinly scattered along their devious windings. The county, however, is rather scantily supplied with timber,

The principal streams are Rock river, Otter, Rock, Elkhorn, Buffalo, and Sugar creeks, and some few smaller tributaries of these.

Rock river enters the county at the center of its eastern boundary line, and takes its exit in its south-western corner. Its general course is straight, its deviations crooked and many; its current is broad and swift flowing; its banks are high, except in a few places where alluvial bottoms spread out. Otter creek comes in from Carroll county and soon almost loses itself in the swamps of Willow Island lake, a few miles above Fulton city. Rock creek comes into the county about the center of its northern boundary line, flows in long undulating curves almost south-west, and enters Rock river at Erie. Elkhorn creek comes in near the north-eastern corner, runs in the same general course, and enters Rock river at Como, a few miles below Sterling. Buffalo and Sugar creeks are tributaries to Elkhorn, coming in on the east side.

Rock creek has three or four good water powers in operation. The mills at Sterling are driven by one of the heaviest powers in the State. On Elkhorn creek two or three mills are in operation. On Buffalo creek one mill has been running since the days of the first settlements in that part of the State. Many other seats for fine water powers exist on all these streams. Rock river, at many localities in the county, would furnish water powers almost as heavy as the one at Sterling. At these localities the stream always flows over a floor of solid rock. By constructing coffer dams and partially turning the river out of its channel while the work is going on, materials for the most enduring dams may be quarried at the places where needed.

It will thus be seen that, altogether, Whiteside county is rather sparsely timbered. It is well watered and well supplied with water powers; has abundant agricultural and manufacturing resources; has a diversified surface; and I am now to describe its interesting and varied geological formations.

Geological Formations.

These consist of Quaternary deposits of more than usual interest; unproductive Carboniferous rocks of the true coal horizon; sandstones belonging to the Conglomerates or "Millstone grits," lying at the base of the true Coal Measures; heavy developments of the Niagara limestone; widely extended outcrops of the Cincinnati rocks and shales; and considerable exposures of the Lead rocks or Galena limestone. Building them into a vertical section, the examined outcrops measure about as follows:

Sections of Whiteside County Rocks.

The usual Quaternary deposits, from	10 to 80	feet.
Carboniferous rocks, shales, etc., from	10 to 40	"
Millstone-grit sandstone from	12 to 25	"
Niagara limestone, from	24 to 175	"
Cincinnati group, from	10 to 37	"
Galena limestone, from	15 to 30	"

In most of these outcrops the maximum thickness at some places in the formation was reached. This was not true, however, of the Galena limestone. That deposit runs low, and its outcrops susceptible of measurement are much below its full thickness. I shall describe these formations in the descending order, commencing at the top.

The Quaternary system.—All the divisions of this system are recognized in this county. One of them, at least, is now attracting the attention of capitalists and scientific men in a marked degree. I allude to the Cat-tail peat beds, the heaviest and best deposit of peat perhaps in the State or in the North-west.

Alluvium.—An alluvial bottom extends along the Mississippi river, from Savanna, in Carroll county, to a few miles below Fulton city, in Whiteside county. It is from four to seven miles wide. It is naturally divided into two parts, nearly equal in extent. There is the high table lands not subject to overflow by the spring floods of the river, consisting of sand prairies, sand banks, and occasional tracts of the richest alluvial farm lands. The other half is that low, wet, marshy bottom next to the river, and a chain of sloughs and marshes along the bluffs, subject to overflow at every period of high water. Upon it grows an enormous yearly crop of sedges and grasses, and the heavy alluvial timber belt of the Mississippi river. The sand-beds are finely stratified and contain occasional boulders, and beds of well worn, unassorted gravel. In one of these gravel beds, recently worked by the Western Union Railroad Company, a mass of transported rock of several tons weight was unearthed. It lies at least four miles from the bluff on either side of the river. The sand-ridge in which it was imbedded is evidently an old Mississippi sand-bar, of more recent deposition than the drift proper. How the great boulder came there, is a mystery. Perhaps when the great river extended from the Illinois to the Iowa bluffs, and the vast fields of ice came floating down in the colder springs of a former geological epoch, some of them were freighted with boulders, which, as the ice fields went to pieces, dropped to the sandy bottom of the river. The lower water soaked bottoms sometimes approach in character imperfect peat marshes. The black vegetable mold covering them is often many feet in thickness. It is comparatively free from sand, and when reclaimed from the water is rich and fat, but too cold and sour for general cultivation, until sweetened by tilling and drying. Below Fulton city and on almost to Albany, and from the Maredosia slough to Cordova the alluvium rises into a high, buff colored sand prairie, fertile enough to produce fair crops, except in hot dry seasons, when every green crop is parched and withers beneath the blaze of an August sun. These sand prairies are old Mississippi sand-bars, resting against the bluffs extending east from these two towns, and running north many miles. Near the north-east corner of Garden Plain, the low alluvial bottom strikes off towards the south-east; leaves the Mississippi river altogether; makes a junction with the alluvial bottom of Rock creek in the township of Trenton; and thence extends itself to the alluvial bottom of Rock river near the village of Erie. It contracts to an average width of half a mile. Low, abrupt, oak covered hills rise from its edges. This is the Cat-tail slough, so famous for its magnificent deposit of peat, of which more will be said in another part of this report.

Three distinct river beds are easily recognized at the present time. First, there is its present bed, about one mile wide on an average; second, the low wet alluvial above referred to, and now subject to periodic overflows. When the waters filled this, the river averaged two or three miles in width. Lastly, the river once flowed a broad stream from bluff to bluff, and averaged six or seven miles in width. Then a heavy body of water flowed lazily through the Cat-tail, but as the great stream went down, this branch of it ceased to flow, and in its water-soaked bed gradually grew a great thickness of the best peat.

The Marais d'Ogee or Maredosia slough, as it is usually called, or Dosia, as it is called in the common speech of the people, is another broad marsh, spreading out along the line between this and Rock Island county, and extending in a nearly north and south direction, connecting Rock river with the Mississippi. Cat-tail slough is similar to the Maredosia, runs nearly parallel to it, and is distant some five or six miles from it. When the Mississippi river is high, the water runs south through these sloughs into Rock river; when Rock river is high, the water runs the other way. The highest point between low water mark in the two rivers along the Maredosia is thirteen feet; along the Cat-tail, it is twenty-six. These figures are obtained from actual surveys made along the sloughs in winter. I am indebted to the courtesy of Mr. J. ABBOTT, an accomplished engineer and surveyor of Cordova, for this interesting information.

There can be but little doubt that the Mississippi river itself once flowed through the Marais d'Ogee. The evidence seems conclusive to any one making an examination of these localities. The broad bottom, several miles in width, looks like the Mississippi bottom. Then the mouth of Rock river was a mile or two below Erie. The same broad bottom runs along Rock river from Erie to Rock Island. Round this channel the distance to Rock Island is twenty miles greater than along the present course of the river. If flowing round this way at the present time, this increased distance would give the usual fall of six inches to the mile; but along the present channel of the river from Albany to Rock Island the distance is twenty miles less, and the fall eighteen inches to the mile. Besides this the abrupt, rocky hills approach closer to either bank of the river as it now runs; and there is nothing about it between these two points, having any resemblance to the usual alluvial bottom now under consideration. For some cause the Father of Waters left its old channel and broke through the rocky hills, gaining twenty miles in distance and leaving the upper rapids as the result.*

But leaving this interesting question I will refer to the other parts of the county, where the alluvium is prominent. In the south-eastern part of the county, the townships of Montgomery, Hahnaman, Tampico, Hume, and Prophetstown, are largely made up of wet or swamp lands. Peaty marshes and sloughs intersect the level face of the country. The soil is deep, black, and water-soaked. The famous Green river Winnebago swamp extends across the town of Hahnaman in a somewhat diagonal direction. This swamp is a wilderness of reeds, sedges, and miry sloughs, in which countless thousands of wild geese, ducks, swans, and other aquatic birds, in proper seasons congregate and find an almost Arctic isolation.

At almost any of these localities the origin and formation of the prairies is well illustrated. The high land round the swamps, aided by a vast yearly decaying vegetation, is encroaching upon the marshes and building them up into dryer prairie land. But the county of Whiteside is reclaiming her swamp lands, by an efficient system of ditching, faster than Nature ever dreamed of doing. Thirteen miles of big ditch are now finished and under contract. Already, hundreds of acres of land, after being drained, have advanced in value from a few cents to many dollars per acre in value. The scheme promises to add greatly to the material wealth of the county.

The usual dark surface, organic, gein soils of the prairies, the leaf molds of the groves, the sands and gravels recently deposited by Rock river, and the white soils of the barrens and oak timber tracts, may be said to make up the rest of the alluvial deposits.

Loess.—When the Mississippi occupied the higher of the three beds above referred to, and extended from its eastern to its western line of bluffs, and in many places spread out over the level prairies, the term river was hardly a proper designation for the great sheet of water. It approached more nearly the character of a great lake or inland sea of fresh water, with its surplus water falling over the mountain chain of its southern boundary, like some Niagara, pouring out the overflow of the great lakes of the North. This barrier over which the water rushed, crossed the river, like a great dam, where the "Devil's Bake-oven" is now pointed out to the traveler. As this was worn down and the bed of the Mississippi lowered, the water assumed more and more the form of a river, draining the great basin thus exposed. The action of the low running waves and other aqueous agencies threw up and arranged in part the bluffs around its shores, while the great basin was full of comparatively currentless water. This deposit is the loess. It is composed of light colored, finely comminuted clays, white and yellow sands and sandy marls, all generally partially stratified, and containing lacustrine and fluviatile shells and other fossils. The loess bluffs are generally bald knobs, covered with short tufts of grass. A good example of the loess may be seen where the North-western railroad strikes the bluffs east of Fulton city. The bluffs here are made up nearly altogether of the loess. South of this, along the Cat-tail, the bluffs are in part capped by the same deposit; but in going north they soon rise into the rocky walls and high mural escarpments of the Niagara limestone. The low hill north and west of Morrison is partly composed of loess clays. Rock river and the smaller interior streams did not present favorable conditions for this deposit to take place, and we seldom find it away from the bluffs of the Mississippi river.

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*Note.—It would seem more probable that the ancient river or ocean current, by which the valley now occupied in part by the waters of the Mississippi was excavated, was divided somewhere in the vicinity of Fulton, and that one arm ran through these sloughs into what is now the valley of Rock river, while the other followed along the present channel of the Mississippi, thus making an island of the northern part of Rock Island county. We have elsewhere attempted to show, in a former volume of these reports, that the valleys now occupied by the Mississippi and the Illinois are older than the drift, and consequently could not have been formed by the existing rivers. For a more full discussion of this subject the reader is referred to Vol. 1, page 7, et. seq. A. H. W.

Drift.—There is a marked distinction between the drift in this and counties farther east. The coarse gravel beds of its upper division are almost entirely wanting. The recent gravels of Rock river were the only real gravel deposits I observed. The usual blue colored and yellow plastic clays of the lower drift cover the underlying rocks in many places to a considerable thickness. At one locality a well was sunk twelve or fifteen feet through yellow unctious clay; then blue clay was struck, and in about fifteen feet more a great quantity of sticks and wood, apparently cedar and pine, was found. The water in the well, of course, had a brackish taste. This woody deposit was about the base of the true drift. Occasional boulders are found in the ravines, but they are no where abundant. Over the northern parts of the county, and especially that portion underlaid by the Galena limestone, the reddish clays or hard pan of the lead region exists to a considerable depth. These drift clays however, as developed in this county, have in them nothing of peculiar or marked interest, except that they bear evidences of peaceful forces rather than that tremendous power which strewed the boulders and piled up the gravel beds in many places in the neighboring counties. Whether the floating iceberg, or the slow crawling glacier, or the strong water currents, or all these combined, transported the coarser materials of the drift, the force of the powerful agents were much modified in their action here. In the spring of the year the ice in Rock river sometimes, impelled by the strong current, gorges, until it rises to the hight of fifteen or twenty feet, and then with a cracking roar it tears rocks from their beds and trees from its banks, grinds them in its strong jaws, and throws them high on the land or strews them along its bottom. But away from the river the clays of the drift appear as if deposited and arranged in peaceful waters.

The Carboniferous System.—While making examinations at Sterling, I was repeatedly told that coal had been found three or four miles below the town. The supposed outcrop was stated to be a thin seam in a bend of the river, not far from the edge of the water. The same statement is made, I think, in Dr. J. G. NORWOOD'S small report upon the coal-fields of Illinois. I sought out the locality, examined the river, and made inquiries of an intelligent farmer, who has resided near the spot for many years. With him the existence of coal in the neighborhood was a faint tradition, nineteen or twenty years old. An examination of the river showed that its bed or floor consisted of the soft, white, dendrite speckled upper division of the Niagara limestone. Gravelly banks of river drift rose on one side some twenty-five feet from the water's edge; a low alluvial bottom lay between the river and the high prairie on the other. No sign of any outcropping rock exists, except in the bed of the river. This is the general character of Rock river from Sterling to about seven miles below Erie. No coal seam or outcrop of coal, in my judgment, exists at the point designated. Some one, digging along the banks of the stream at an early day, doubtless came upon a small deposit of float or drift coal. Tradition has kept the circumstance alive, and it grows with the passing years.

The edge of the Coal Measures, however, extends thinly into Whiteside county, at its south-western corner. Opposite Erie, the south bank of Rock river begins to assume the character of a low bluff-line. In descending the stream these bluffs rise in altitude, become more abrupt and broken; and such are their general characters until the Mississippi range of bluffs is reached, several miles below Rock Island. For most of the distance the glancing waters of Rock river hug their bases. On the north side of the stream the low alluvial bottom spreads out, widening in proportion as the range of hills rise in hight. A hundred feet is perhaps the highest altitude attained by these bluffs. A short distance below the western line of the county, coal begins to outcrop in the sides of these bluffs. Still lower down, at Aldrich's coal mine, the seam is some four feet thick, and is extensively worked. Cannel coal, soapstone, fire clay, black-slate, and a stratum of black limestone are associated with the coal. The outcrop is in the side of the hill, at a considerable elevation above the waters of Rock river. Below this mine, and in close proximity to it, several Sterling capitalists own land, and have opened drifts into the hill. Still lower down, at Cleveland, coal is extensively mined; and lower down, Coal valley is pouring its black treasures into Rock Island, and from thence is distributing in every direction the old imprisoned heat and blaze of the Carboniferous ages, to warm our prairie homes through the bleak winters. My field-work, however, did not extend into these rich coal regions, and I refrain from further description of them.

These coal bluffs extend for a few miles into Whiteside county. But no productive coal seam has yet been found in them, within its limits. The bluffs run too low, by the time the county line is reached, to indicate a workable coal vein. A thin seam and light outcrops may be discovered, but so far as the economical geology of this county is concerned, the Coal Measures may be set down as unproductive. No workable beds extend within its boundaries.

The Unionville Sandstones.—In the northern part of the township of Hopkins, I unexpectedly found a low outcrop of sandstone in a ravine. The stone was soft and friable; in color it varied from a dirty-white to a clouded or yellowish-red; it easily crumbled beneath a blow of the hammer, and could be cut or hewn readily with a common ax. It resembles the St. Peter's sandstone, and at first surprised me not a little. Other outcrops, however, indicated its true geological horizon. The outcrop may be found on the land of a Mr. Johnson, on section thirteen, if I mistake not. A well, sunk higher up on the side of the ravine, or near its head, penetrated the sandstone about thirty-three feet, when the bottom of the bed was probably reached. This locality is about eight miles east and a little south of Morrison. A line drawn from Johnson's nearly west to Unionville, and thence south-west to Mineral Springs, in the south-western part of the county, would pass through six or seven localities where this sandstone outcrops, or has been dug into. About three miles west of our first outcrop, and not far north of the village of Round Grove, is the locality of the famous walled well of Whiteside county. Some ten years ago an article went the rounds of the papers, stating that in digging a well at this locality, after a depth of twenty-five feet was reached, the top of an old walled well was discovered, which showed unmistakably that it was the work of human hands. The old well was filled with debris. After removing this to a depth of several feet, sweet waters rose, until the wall of the old well was covered.

The supposed discovery, at the time, excited general and even scientific interest. I sought out the old well, and tried to learn its history. It is now filled up. The porch of a farmhouse extends over it. Its wonderful story was freshly told to me, in the truth of which the narrator seemed to have full faith.

Something like a walled well was, no doubt, actually discovered; but from all the light I could obtain on the subject, I think it was only a rounded excavation in the underlying sandstone—a pot-hole, perhaps—worn out by an eddy and moving pebbles revolving in a circular motion. In sandstone, with broken and thin-bedded strata, the inside of such an excavation would present exactly the appearance of an artificial well. And thus, this supposed wonder, like the walled lakes o Iowa, and other supposed works of art, is susceptible of a simple and satisfactory explanation.

To me the chief interest in the well consisted in the fact, that its walls were built of my newly discovered sandstone, enabling me to trace the general course of its deposit.

The next outcrop is in the grove about one mile east of Unionville. Here it is quarried to a considerable extent.

But the most characteristic outcrop is at Unionville, one mile north of Morrison. Here a heavy quarry is largely worked. A section of this quarry shows about nine feet of light marly clay, resembling loess, about three feet of alternating clays and soapstone, and twelve feet of massive, heavy-bedded sandstone. Three strata or layers of the latter outcrop, each from two to three feet thick, separated by layers of soapstone imbedded in thin seams of clay. One of these soapstone layers is six inches thick. It is of a blue-white color, greasy and unctuous to the touch and feel. The sandstone layers are soft, light-colored, finely-grained arenaceous rocks. They can be hewn into any shape with an old ax, but when seasoned and dried, they harden into a fair building stone. The surface of some of the larger blocks is beautifully covered with very distinct ripple and wave marks.

About seven miles south-east of Unionville, on the Poor farm, is another outcrop. It is in the face of the east bluff of the Cat-tail. This quarried outcrop is similar to the one just mentioned. The bluffs on both sides of the Cat-tail, in this vicinity, show signs of this sandstone.

At Mineral Springs, on Kingsley's Grove, still further to the south-west, the borings of a small artesian well showed it to be the underlaying rock. This well was put down in oil-fever times. Some indications of oil exist about these chalybeate springs; but after prospecting awhile, the enterprise was abandoned.

Following the same general course, we next find outcropping sandstones in the Mississippi bluffs, near Hampton, in Rock Island county. The rock has a resemblance to the Unionville sandstones, but probably belongs to the true Coal Measures, a little higher in the geological scale.

The sandstone deposit rests unconformably upon the Niagara limestone. At one time it was thicker, and covered a larger extent of the county, but the erosive and denuding forces of past geological ages have worn it down and carried it away, until nothing but small patches and basins remain.

Its place in the strata of Illinois rocks is at the base of the Coal Measures. It belongs, I think, to the Millstone grit, which, in the West, is often only a fine-grained, arenaceous rock; but in other localities, is made up of coarse sandstones, pebbly conglomerates, and grits.

Fossils.—The Unionville quarry has afforded a considerable number of impressions and casts of fossil plants. The most conspicuous among these is a Calamite, the *Calamites cannæformis*, I think. The casts of this plant are from one and a half to four inches in diameter, the joints from three to about eight inches in length, the surface finely marked with longitudinal lines. The friable nature of the rock makes it difficult to obtain specimens. A species of *Lepidodendron* has also left some well-defined impression. It seems to have been as thick as a man's arm, and the impressions have a rough, shark-skin, rattlesnake-like appearance. I could not obtain a good specimen, and am unable to give its specific name. Some other sections of what appeared to be a plant, were observed; but the impressions were too indefinite for identification.

The Niagara Limestone.—A large extent of this county is underlaid by this formation. Probably all that part of the county south of Rock river is underlaid by the Niagara, except a little strip along the Sterling dam, and the carboniferous bluffs below Prophetstown. In all this extent of territory there is not an outcrop or quarry, however, of any kind, except those in and along the bank of Rock river. The surface is low, and the underlying rock runs low. The river, from Sterling to its exit out of the county, every few miles, runs over rocky beds of porous, dendrite-specked, yellow Niagara limestone. Just below the dam at Sterling, at Lyndon, at Erie, seven miles below Erie, and at many other intermediate localities, quarries are opened at the water's edge, or in the floor of the river; and, judging from the appearance of the low wet prairies south of the river, the Niagara runs back nearly level, perhaps, beyond the southern limits of the county, before running under the Bureau and Henry county Coal Measures.

About a mile above Sterling, on the north bank of the river, a series of Niagara quarries are extensively worked. The formation here is worked down about thirty-five feet, and the rock is full of chert bands, and is speckled with dendrite markings. The layers, although thin-bedded, are so uncouth and rough that no mason could build them into a handsome wall. The bottom layers are of a dull green color, and soon pass into the underlying Cincinnati shales.

Quarries of the Niagara are also worked near Empire and Como, one of them in the bottom of a little tributary of Elkhorn creek. The outcrops here are low and not very heavy.

Westward of these latter places and in all that tract of country bounded by the railroad track, Rock creek and Rock river there is scarcely an exposure of any kind; but this irregular-shaped triangle is nearly all underlaid by the Niagara limestone.

Rock creek, from the north line of the county to Morrison, and in fact to its mouth above Erie, cuts into the underlaying rock and exposes it at numerous places. All these exposures belong to this formation, except the sandstone at Unionville and Mineral Springs. At Brothwell's mill the exposure is sixty feet thick, presenting a perpendicular bluff, cavernous, and light-colored on a recent fracture. Just above Jacobs' mill an extensive quarry is opened in the same limestone. In the hill north of Morrison it is again quarried. At this latter place a lime kiln is in successful operation. Some of the layers here have in them many small, curiously shaped cavities, lined with a velvety looking, lead-colored metalic substance.

The bluffs along both banks of the Cat-tail, with the exception of a few sandstone outcrops, show the Niagara limestone.

That high plateau of land bounded by the Cat-tail, the Maredosia and the Mississippi, and consisting of the townships of Newton, Albany and Garden Plain, is underlaid by the same rock. At Albany a high rocky hill, with an old shore line of the Mississippi, fifty feet above present low water mark, rises a short distance back from the river.

The hill north of Fulton City, and on which it is partly built, is an outcrop of Niagara limestone. At one time it was a small rocky island in the midst of a broader and mightier stream than the present Mississippi river.

But the grandest development of this formation, perhaps, in this part of the State, may be seen along the Mississippi bluffs, near the north line of the county. After viewing these beetling cliffs, the appropriateness of the old name "Cliff Limestone," becomes apparent. This bold exposure rises at its highest altitude to the hight of one hundred and seventy-five feet above the level of the bluff road, and this is but the upper portion of the formation at this place. The talus and debris of ages have accumulated along the base, rising in slopes half way up the steep aclivity. Loose stones, sometimes weighing tons, loosened by the frosts and other atmospheric agencies, have rolled down, and thickly strew the roadside. Sweet, sparkling, deliciously cool water gushes in strong springs from little ravines. Wild grape vines, dense thickets and old monarch oaks cover these talus slopes for the most part; but sometimes the scene is varied by a slope covered with short tufts of prairie grass, or the richer and softer blue glass. The upper part of the exposure resembles dilapidated Cyclopean walls of the mystic times. A long mural escarpment rises from the top of the slopes, and presents its castellated face to the broad Mississippi Valley, whose lacustrine waves in older geologic epochs beat against the rocky barrier and wore it into fantastic shapes. Many caverns exist, some of them almost inaccessible, out of which issued, the day I spent among them, the half human cries of wild cats and the growls of a small species of lynx. Some miles of stone wall along the road are built, by quarrying the material on the tops and sides of these steep rocks, and letting it go plunging down to the very places where it is needed. The little farms thus fenced along the public highway have a fat, rich, sour cold soil, too wet for very successful cultivation, except in occasional mellow localities. As we recede from this bluff line towards the interior of the county the Niagara limestones thin out by erosive and denuding agencies, until the Cincinnati shales and the Galena limerock successively come to the surface. This is especially true along the northern part of the county, where the exposure is so much the heaviest.

In the large area of Whiteside county underlaid by this portion of the upper Silurian rocks, I noticed considerable difference in lithological character. The exposure just referred to consists of the upper "Coraline and Pentamerus beds" of the Cliff or Mound limestone of the earlier western geologists. It is compact, homogeneous in structure, full of minute specks of dendrites, of a light straw-color on a recent fracture, sometimes taking a reddish tinge, nearly the color of brick dust. At Sterling the lower part of the formation is exposed. This is a thinner bedded, rougher, uglier stone, and would hardly be recognized as the same rock just referred to. At Fulton City, the upper part of the quarry, at least, is a friable yellow-colored or ocherous limestone, sometimes porous or sponge like, and sometimes of a tough crystaline texture. Sometimes the color approaches an almost white cream-color. It is identical with the Racine limestone of Mr. LAPHAM, referred to in the Wisconsin geological survey. At Lyndon the rock is porous and full of the stems of encrinites. Below Erie, near the point where Rock river leaves the county, the color is still lighter and more delicate, the texture more compact and finer grained, and the stone is in every respect, I think, identical with the Leclare limestone, now recognized as a member of the Niagara formation.

Organic remains.—The characteristic fossil of the upper beds perhaps is the *Pentamerus oblongus.* In the speech of the people, masses of it are commonly called "petrified hickory nuts." At Brothwell's mill many of them are sticking through the rocks; but at the heavy exposure along the bluffs huge stones are coverrd over so thickly with the casts that they seem to be an aggregated mass solidified with a calcareo-magnesian cement. In the old Niagara seas they must have grown in countless millions, like oysters in a modern oyster bed. Some of these vast slabs would make attractive specimens for the geologist's yard; but good cabinet specimens are hard to obtain. Along the Niagara ridges and in the ravines, casts of corals turned to silex may be picked up in great quantities. Among the most common is the well known chain coral, the *Halysites catenularia*. *Favosites Gothlandica*, *F. favosa*, *F. Niagarensis*, *Stromatopora concentrica*, *S. rugosa*, *Astrocerium venustum*, one or two species of *Cyathophyllum*, stems of *Encrinites*, and fragments of *Orthoceras* of at least two species, are all very abundant.

From the abundance of these silicified corals, coral reefs must have existed in the old Niagara seas, where countless millions of these little animals lived and built, as the modern coral builders raise up from the modern ocean's floor, reefs, atols and islands.

In these clear coral growing seas, sea weeds or fucoids abounded, and in the Sterling quarries are woven over some of the layers in a perfect net-work.

Cincinnati Shales.—The rocks of this formation, formerly designated as the Hudson river shales, but now known as the Cincinnati group, show surface exposures over a considerable portion of the county. Along the rapids at Sterling on the banks of the river, and at the base of the bluffs under the Niagara quarries already referred to, the various rocks, shales and clayey and bituminous deposits of this formation may be seen. The rapids in the river are to some extent produced by the wearing away of these deposits. They rise at a considerable angle from beneath the Niagara rocks just below the dam. On the south side of the river the formation can hardly be distinguished, but on the north side, a mile above town, it attains a thickness of thirty-seven feet, from the surface of the water to the base of the Niagara limestone. From thence it runs round east and north of Sterling, three or four miles distant from the city, striking off into the large Cincinnati surface exposures in the neighborhood of DR. PENNINGTON'S residence. In this circular belt there are no surface exposures after leaving Rock river, but the wells dug indicate the existence of these shales and shaley limestones. The inevitable blue clay and creamy colored water, oozing from some small ravines above Sterling, are unfailing indications of this deposit, even where no outcrop is visible.

That high plateau of level prairie between Elkhorn and Rock creeks, and extending from the railroad track to a mile within the limits of Carroll county, except a small portion of the southwest corner, is underlaid by the rocks of this group. This elevated water shed contains large portions of four or five townships. Round its eastern and northern edges, and in many ravines inside of its boundary lines, good exposures and artificial outcrops may be examined. Rock creek cuts into the Niagara, and Elkhorn creek cuts into the Galena limestone, but the Cincinnati rocks and shales run over the one and come from under the other, in less than one mile from either stream. Along its northern limits it rises to the altitude of almost a hill, overlooking the low-lying Galena deposits of Carroll county. Three or four quarries are opened along the face of this elevation. The average thickness of these exposures is about twenty feet. The stone is thin-bedded, easily broken, close in texture and light in color, having a dry or baked appearance. The bottom layers are thicker bedded and have a faint green and blue tinge. It is an argillaceous shaly limestone. At Bressler's mill on the east side of the ridge there is a low outcrop just above the water's edge. Here the rocks are stained by iron-impregnated waters, flowing from some springs just above them. Nearly a mile north-west of this is Dr. L. S. PENNINGTON's large quarry, opened at a considerable distance from, and elevation above Elkhorn creek. The exposure is stripped of the overlaying clay and worked into about thirty feet. A drain is constructed to lead off the water. The upper portion of the quarry is thin-bedded, but the layers can be lifted in immense slabs. No better flagging stone can be obtained anywhere. The lower portions of the quarry are thicker-bedded, compact and very blue. On section three, in the township of Hopkins, there is another splendid quarry of this stone. The part worked is about twelve feet thick. It is covered by a few feet of finely comminuted, light-colored clay. A circular pool of sweet, clear, cold water, fed by some large springs, lies in placid tranquillity almost in the quarry, and throws off a laughing stream. The stone here is a hard, thicker-bedded, compact, argillaceous limestone, unlike the usual crumbling shales of the Cincinnati group. Two or three of the bottom layers are of a deep ultra-marine blue color, with shaly and clayey partings of a few inches thickness between them. The locality is known as Hecker's quarry. It is now owned by Dr. PENNINGTON.

There is another quarried exposure nearly a mile north of this, at Harvey's. The stone here are soft, shaly, and crumbling. The tooth of time makes sad havoc with them. When exposed to the atmosphere they soon begin to decay.

Here I noticed some disturbances in this usually quiet formation. Over a few sections it seems to be thrown out of shape. Not far off some Niagara rocks are found where they do not belong, according to outcrops and the signs in the surrounding hills. These lost Niagara rocks are evidently not *in situ*, but have been moved probably by the drift forces.

The lithological character of the Cincinnati rocks examined in this county deserves a passing thought. The carbonaceous and bituminous shales found further north, which are there a very marked feature, are here almost entirely wanting, or are at least not distinguishable by ordinary observation. The stone is compacter, and less liable to decay, than that examined in many other localities. It approaches nearer an ordinary limestone in structure and in uses. And altogether it is a valuable deposit, as I shall show in speaking of the economic geology of the county.

Organic Remains.—These are not very abundant. Most of the heavily worked outcrops are barren of fossils. In the ravines cutting the formation on the north the *Chaetetes petro politanus*, *Orthis testudinaria*, *O. occidentalis*, *O. lynx*, and a small *Brachiopod*, probably a *Leptæna*, are often picked up, weathered out in great perfectness. The spines and shields of a characteristic trilobite, the *Asaphus gigas*, are not rare, but perfect specimens are seldom found. At Sterling some of the thin layers are exceedingly hard, almost flinty, and are thickly covered with fossils. Conspicuous among these is the *Strophomena alternata*, and many other shells common to this and the Trenton period.

The Galena Limestone.—This becomes the surface rock to some extent along the northern and northeastern part of the county. That irregularly shaped parallelogram in the latter locality, north of Sugar creek and east of Elkhorn creek, is all underlaid by the Galena limestone. Buffalo creek cuts this piece of land in a diagonal shape. For two or three miles west of Polo this creek runs over and shows exposures of the Blue limestone; but at Sanfordsville, near the line between this and Ogle county, this rock outcrops heavily just below the dam for the saw mill. The outcrop has been worked to the depth of twenty four feet. The layers are massive, solid, and subcrystaline. At the present time the quarry is not much worked. Following the creek down a few miles, the next exposure of consequence is at Wilson's mill. Here there is a quarry worked to the depth of about twenty feet. The stone is similar to that at Sanfordsville. Other small outcrops may be seen in this locality in some small ravines in a white oak grove of some extent.

On Elkhorn creek, at Allison's mill, just across the line in Carroll county, there is a worked exposure some eighteen or twenty feet thick. The stone here is of a white cream color, and quite handsome in appearance. From this locality nearly to Bressler's mill, just east of the residence of Dr. PENNINGTON, the Galena is the surface rock. It runs low, however, and soon disappears below the overlying Cincinnati group.

The central part of that broad stretch of prairie and rough land north of Morrison, and lying between the Mississippi bluffs and Rock creek, is also underlaid by this rock. There is no conspicuous outcrop anywhere over it; but some of the ravines, especially near the Carroll county line, show its peculiar gravels, red hard-pan, and low-lying, crumbling outcrops.

There is nothing noteworthy connected with this limestone as a surface rock in this county. Its superficial area is limited, its outcrops are few, and the only scientific interest attached to it is the knowledge of its existence among the other interesting formations of the county, and the fact that it may become of economical interest for the manufacture of quick-lime.

It is almost barren of fossils. I only noticed fragments of a few characteristic species. Near the northern part of the county I found a rather poor specimen of *Receptaculites orbicularis*, as figured and described by **Dana**. The other fossils were merely pieces of *Bellerophon*, *Pleurotomaria*, and *Murchisonia*.

Economical and Agricultural Geology.

This department of Whiteside county geology is of more than usual importance, both in a scientific and economical point of view. The variety of rocks; the new interest awakened in the cultivation of the vine; rich and varied agricultural resources; the great beds of excellent peat existing in hitherto useless bogs, and the fat lands now being successfully reclaimed from the swamps—all these are matters of wider interest than usually appertains to a single county.

Building Stone and Lime.—All the outcropping formations above described furnish materials for ordinary mason work, such as cellar and well walls, foundations, and public buildings. The Galena requires much labor to quarry and work it into good shape; but it lasts like granite, has an attractive, warm, fashionable cream or straw color, and for heavy, massive masonry has no superior. Its limited outcrop prevents its general use for economical purposes. It burns into a good article of quick-lime. There is a lime-kiln in successful operation at Wilson's mill. While at Sterling I observed some capitalists, who were intending to manufacture a quantity of lime, figuring whether they could haul stone to the fuel or fuel to the stone the cheapest, the one being in Sterling and the other on Buffalo creek. I did not learn the result.

For common rough mason work the Niagara limestone is much used. Some of its layers make a good quick-lime, as may be seen on the ridge north of Morrison.

The sandstones of Unionville and the county farm are also extensively used for building purposes. The mill between Unionville and Morrison is built of this soft gray stone. It is a handsome and substantial structure. The jail and court house foundations, and the public offices in

Morrison belonging to the county, are of the same material. When first quarried it is so soft that it can be hewn into any shape with an old ax. It then appears unfit for building into any structure. But when laid up in a wall it dries, seasons, and attains a firm texture. The ease with which it can be worked recommends it, where dressed stone is desirable.

In some places the shales and rocks of the Cincinnati group are considered unfit for permanent mason work. It is supposed that atmospheric agencies will eventually destroy their beauty and injure their durability. But so far as tested, the quarries of the Cincinnati group in this county furnish a lasting and desirable material for economic uses. The layers are of convenient thickness, and break into any desired size. The flag stones raised at Dr. PENNINGTON'S home quarry are as large as need be wished for. This gentleman, with his accustomed energy and a large expenditure of money, has two large quarries in operation. He has also a stone yard in Sterling, where he can furnish stone from his quarries in any quantity, and dressed into any desired shape. He supplies this stone yard from the quarry near his residence, and from the Hecker quarry in the township of Hopkins, already referred to in this report. A handsomer looking lot of stone than those quarried and corded up at the latter locality last fall, one seldom ever sees. I hope merited success will crown Dr. PENNINGTON'S efforts to develop this branch of the material wealth and industry of the county.

As pertinent to this part of our subject, I here insert a table showing the tests and properties of many samples of stone. Some of them are from the quarries of the Cincinnati group just referred to. Others are from the Niagara limestone from different localities in Northern Illinois. The table is given entire, on account of the interesting nature of its contents, and as furnishing a basis of comparison between our Northern Illinois and some other rocks. It was furnished to myself and Dr. PENNINGTON by the government officials on Rock Island. I regretted that no specimens of the Galena limestone were present to be subjected to the same trying ordeal. It will be seen from the table that the samples of stone from Dr. PENNINGTON'S Cincinnati quarries were in many respects superior to the LeClaire limestone, out of which the United States Arsenal at Rock Island is built, and were almost equal to the Joliet marble, out of which the United States Armory is being constructed :

Table showing Properties of Stone.

Kinds of Stone.	Dimensions in inches.	No. Samples.	Specific gravity.	Crush'g force in lbs.	Crush'g force in lbs. per square inch.	Began to spawl.	Breaking wt. for transverse strain	Transverse strength — *L W ÷ S—4 b d.
Athens marble, (Illinois Stone Co.), Magnesian limestone.	Transverse 3 75 by 7 9 by 20	1	2 5154	65, 700	16, 420	65, 700	16, 900	=361 5
	3 9 by 7 05 by 20	2	2 5132	49, 000	16, 255	49 000	18, 580	=377 4
	4 by 8 by 20	3		64, 800	16, 700	64, 000	16, 600	=324
	Crushing 2 by 2 by 4							
			2 5143	60, 500	15, 125	59, 567	17, 360	=354 3
Athens marble. (Walker), Magnesian limestone.	Transverse 4 by 7 5 by 20	1	† 2.6629	34, 500	8, 625	28 000	12, 100	—172
	4 by 8 by 20	2	2.5271	43, 700	10 950	39, 000	16, 800	—328
	3 8 by 8 by 20	3	2 5246	38, 000	9, 500	38, 000	14, 300	—294
	Cushing 2 by 2 by 4							
			2 4051	38 733	9, 692	35, 000	14, 400	=264 5
Joliet (State Prison) Magnesian limestone.	Transverse 4 by 8 by 20	1	2 6123	40, 000	10, 000	20, 000	13, 800	=269
	4 by 8 by 20	2	2 6086	31, 270	7, 817	18, 000	15, 000	=293
	4 by 8 by 20	3		33, 000	8, 150	19, 000	18, 800	—267
	Crushing, 2 by 2 by 4							
			2 6105	34, 757	8, 656	19, 000	15, 867	—276 5
Magnesian limestone.	Transverse 4 by 8 by 20	1	2 6526	64, 000	16. 000	64. 000	15, 309	—298 7
	4 by 8 by 20	2	2.6354	47, 000	11, 750	44, 000	16, 400	=220 3
	4 by 8 by 20	3		65, 500	16, 375	65, 000	......	=248
	Crushing 2 by 2 by 4							
			2 6140	58, 883	14, 708	57, 833	15, 850	—283
Nauvoo, Pure limestone.	Transverse 4 by 8 by 20	1	2 6378	31, 400	7, 850	......	14, 600	—285
	4 by 8 by 20	2	2 7028	36 200	9, 150	......	14, 000	—273
	4 by 8 by 20	3		35, 000	8, 950	......	14, 600	—285
	Crushing 2 by 2 by 4							
			2 6703	34, 200	8, 583	......	14, 300	—281
Blue stone, (New York) or North river flag stone.	Transverse 30 by 4 by 3	1	2 7249	84. 600	21. 150	......	4, 000	=623
	30 by 4 by 4	2	2 7242	95 300	23, 825	......	5, 680	=665
	30 by 4 by 5	3		89, 500	22, 375	......	8, 890	—616 75
	30 by 4 by 6	4				......	10, 000	—520 8
	Crushing 2 by 2 by 4							
			2 7245	89, 800	22, 450	......	7, 142	—609
Le Clare, (Old Quarry). Magnesian limestone, very impure.	Transverse 4 by 8 by 20	1	2.3354	13, 000	3, 250	11, 000	6, 590	—127 7
	4 by 8 by 20	2	2 3379	13. 800	4, 700	18, 800	6, 800	—130 5
	Crushing 2 by 2 by 4			20, 000	5. 000	20, 000		
			2 3366	15, 600	4, 317	16, 600	6, 695	=129.6
Le Clare (New Quarry). Magnesian limestone.	Transverse 4 by 8 by 20	1	2 3712	24, 900	6, 225	24, 900	7, 000	=136.6
	4 by 8 by 20	2	2 3033	29, 800	7, 450	25, 000	9, 100	=177.
	Crushing 2 by 2 by 4			21, 500	5, 375	15, 000		
			2 3372	25, 400	6, 350	21, 633	8, 050	=156.8
Andalusia, Magnesian limestone (very impure).	Transverse 3.8 by 7 95 by 20	1	2 3790	24, 200	6, 050	......	5, 900	=112
	3.7 by 8 by 20	2	2 4067	28, 100	7, 025	......	5, 000	=105.
	4 by 8 by 20	3	2 3812	20, 000	5, 000	......	3, 600	=103.
	Crushing 2 by 2 by 4							
			2 3389	24 100	6, 025	......	4, 833	=107.
Sterling, Ill., (Pennington) Magnesian limestone.	Crushing 2 by 2 by 4 f'm top		......	27, 540	6, 885	5, 250	......	....
	" 2 by 2 by 4 f'm bot'm		......	40, 000	10, 000	3, 250	......	....
Hopkins, Ill., (Pennington)	Crushing 2 by 2 by 4		......	34, 000	8, 500	6, 000	......	....
Wills Quarry, Hancock, Ill.	Crushing 2 by 2 by 4 f'm top		2.468	32, 100	8, 025	25, 000	......	....
Wills Quarry, Hancock, Ill. (Magnesian limestone.)	" 2 by 2 by 4 f'm bot'm		2 387	16, 000	4, 150	9, 000	......	....
Rickeys Quarry, Lee Co., Iowa (Sandstone).	Crushing 2 by 2 by 4		2 180	15, 700	3, 925	15, 700	......	....

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*NOTE.—The product of the length and width divided by 4 times the breadth and depth gives the transverse strength.——— †Defective.

To determine the absorptive properties of different stones, the following varieties of different stone were placed in the boiler of a steam engine and remained for sixteen (16) days. They were then weighed, and then placed in water, where they remained three (3) days and nights, and were again weighed, with the following results:

Kinds of Stone.	No. of specimens.	Weight before steeping, in grains.	Weight after steeping, in grains.	Increase in weight, in grains.	Increase per cent.
Athens (Illinois Stone Company)	1	5554	5755.5	201.5	3.6
" " " "	2	5421.	5593.5	172.5	3.1
Athens (Walker)	1	5020.	5184	164.	3.26
" "	2	5140	5309.	169.	3.28
" "	3	5230	5400.	171	3.26
Joliet (State Prison)	1	5293.5	5495.3	101.8	1.8
" "	2	5306.3	5432.5	126.2	2.3
Joliet (Sanger)	1	6211.8	6382	170.2	2.73
" "	2	6640.5	5800.	159.5	2.8
Nauvoo	1	5498	5513.5	15.5	.33
"	2	5578.7	5599.5	20.8	.39
Blue stone, New York	1	5635.	5661.5	26.5	.47
" "	2	4179	5498.5	19.5	.45
Le Claire, new quarry	1	4999.7	5361.2	361.5	7.23
" old quarry	2	4333.	4674.	341.	7.8
Andalusia	1	4611.	4874	263.	5.7
"	2	4902.	5181.	279	5.68
Wills quarry, from top	1	4798.	4924	126.	2.5
" from bottom	2	4425.	4701	276	6.
Rickey's quarry	1	4029	4230.	201.	5.

The soils, clays and sands have been sufficiently referred to in speaking of the surface geology of the county. They furnish the usual materials for economical purposes and uses, and need not now be more specifically referred to.

Vine Culture.—The cultivation of the vine in some parts of the county is awakening deserved attention. The experiment, so far as tried, has been eminently successful. Several amateur grape-growers in the city of Sterling are devoting some attention to this interesting branch of industry. Their success has been most flattering, and there is a well grounded belief springing up that both grape-growing and wine-making, in favorable localities in Northern Illinois, may be made a source of profit to the cultivator. The soil in and about Sterling seems well adapted to vine-growing.

At Morrison, the soil partakes somewhat of the nature of the loess clays. The vine flourishes in it in the greatest luxuriance. I observed, last fall, one little vineyard just below the town, on a southern slope of the hill, which seemed from the highway nothing but a mass of purple grapes. I have since been furnished with some statements as to the amount of fruit raised, mode of culture, and other facts of interest to vine-growers.

The vineyard belongs to CANFIELD BLODGETT, ESQ. He has 140 bearing vines, of which 90 are Concords, 24 Hartford Prolific, 6 Delawares, 6 Crevelings, 6 Taylor White or Bullitt, 6 Maxitawna, and 2 Cuyahoga. The vines were planted three years ago last spring, on soil heavily manured and subsoiled. The crop of 1867 was as follows: 3018 pounds, sold at an average of 16 cents per pound; about 500 pounds were used by the family and friends of Mr. Blodgett; 20 gallons of wine, the pure juice or blood of the grape, were made; layers were sold to the amount of $100; layers yet on hand, about $40 worth; net profits on 140 vines, three and a half years after planting, on a single crop, at least $500. He has since planted 320 vines, not yet in bearing, varieties as follows: 115 Concord, 50 Iowas, 40 Israellas, 50 Delawares, 13 Adirondacks, 13 Ives' Seedling, 13 Clintons, and 26 Hartford Prolifics. The ground for these was trenched two feet deep, and a load of well-rotted manure to every five vines, well mixed with the earth. He takes down and trims in the fall, and covers with earth, and takes up about the middle of May. It takes ten or twelve pounds of grapes to make a gallon of wine—pure juice—and two pounds of sugar. Where one-third water is used it takes more sugar, and the wine is of inferior quality.

The above statement can be relied on, I think, as correct. It shows what may be accomplished on a small scale. It is true, vines would not bear every year as they did in 1867, but they would produce with as much certainty as our most staple products of the farm.

The loess hills along the Mississippi, with their marly clay and sands, may be made to do even better than this. Proper care in planting, and a generous after-culture, would produce this delicious fruit and a generous, invigorating wine in the greatest profusion.

Grape-growing and wine-making in this country is rapidly rising to a prominent position among industrial pursuits. In California, it is now the leading interest of the State, surpassing in importance the production of gold. In a few years, even now, perhaps, it does surpass all other interests combined. Our California wines are becoming as familiar as the products of the vintages of the Old World. Cincinnati wines establish the fact that the Ohio valley is eminently well-adapted to vine-culture. The hills of the Missouri river are attracting to them the wine-making Germans from the best vine lands of the Rhine, and of other famous wine-producing countries.

The loess bluffs of the Mississippi, about Warsaw, Nauvoo, Fort Madison, and in that locality, are surprising horticulturists by the adaptability of their soil and climate for the growth of the vine and its abundant yield of grapes. In this latter locality the Catawba is the favorite wine grape. It has stood the test of a severe trial, and the wine-growers have faith in it. In Whiteside, Carroll, and counties farther north, the Concord is the favorite grape. It is found to be hardy, prolific, reasonably sure of a crop, and comparatively free from mildew and insect foes. All over the district where the Galena and Niagara limestones outcrop the deep, loose, red soil, intermixed with loose stones, ought to, and will produce grapes that will make a wine of high excellence and great durability, although it may not attain the richness and ripeness of flavor of that grown in sunnier climates. In the latitude of Nebraska, the Concord, Hartford Prolific, Taylor's Bullitt, Ives' and Norton's Virginia, and Clinton, have all, after a thorough test, proved successful. Some of them never show mildew, or a diseased berry, and are not subject to the ravages of insects.

If we could produce grapes for the table and for wine, even as abundantly as we produce apples for the cellar and for cider, how much would be added to our material wealth, our social enjoyment, and the healthfulness of our people. A new and profitable industrial interest would spring into existence; a blow would be struck at the consumption of poisoned and adulterated liquors; and a pure, healthful and invigorating beverage would be furnished, which would do much for the destruction of a perverted taste for alcoholic stimulants. I have a deep and abiding faith, that the awakening interest of our people in the cultivation of the vine, and the making of wine, will do much towards the accomplishment of this result.

Peat.—In Whiteside county peat exists in inexhaustible quantities and of first rate quality. It has become, not only a subject of wide-spread scientific interest, but an element of material wealth, and one of the industrial and economical resources of the county.

The most valuable deposit is found in the Cat tail slough, a low swale running through the highlands from the Mississippi to the Rock river bottoms, in the western part of the county. In width this slough varies from one-half to three fourths of a mile. From Bluff station to Rock creek, the Cat-tail proper, is about ten miles long. A heavy vegetation of sphagnous mosses, sedge grasses, cat-tail rushes, and other aquatic plants cover it. In approaching it from either side over the rolling prairie, no indications of its existence are discovered, until the low bluffs running along either side are reached. The broad, water-soaked swale then opens upon the sight, gray at the touch of October frosts, except where blackened by the sweeping march of recent prairie fires; dotted with haystacks; a creeping stream of antiseptic peat-water, shining like a thread of silver in the shallow black ditch, opened to drain the surplus waters of the bog—thus it appeared when I first went there to pursue my investigations of the peat-beds of the county.

Much and various qualities of young, growing and unripe peat exist all along the slough. But the great bed of fat, ripe peat, which has made the name of Whiteside county peat prominent in connection with the peat deposits of the Northwest, lies near the middle of the Cat-tail, and not far from the water-shed or dividing ridge between Rock and the Mississippi rivers. Mr. NATHANIEL DODGE, who resides in the vicinity, about twelve years ago had his attention attracted to the valuable character of this peat deposit. At first it was cut into convenient sized blocks with a common spade, and dried in the summer sun. Neighboring farmers began to use it for fuel and heating purposes. It was used for burning lime from the Niagara limestone, in the adjoining bluffs. It was hauled to Morrison in small quantities, and burned in offices and dwellings. At length, stimulated by the experiments and successes of eastern peat companies, and the reported examinations of geologists and practical men, a peat fever sprung up in Whiteside county, a steam engine was placed in the swamp, and two peat machines were operated by Messrs. TOWNSEND & DODGE, during the summer of 1867. Three hundred tons of dry, hard peat fuel were manufactured. The experiment was a success. The manufactured fuel became popular and valuable. Peat lands, hitherto considered almost a drug in the market, rapidly increased in value, doubling and quadrupling in a few months. The Union Grove Peat Manufacturing Company of Whiteside county, with a cash capital of one hundred thousand dollars, has just been organized, and its articles of association filed with the Secretary of State. During the summer of 1868, extensive works will be put in operation, and large quantities of peat fuel manufactured.

The bed of peat is in all about six miles long, averages in width about three-fourths of a mile. It contains, altogether, some three thousand acres of peat lands. These lands do not all contain valuable workable peat, but the greater part of them do.

The amount of peat contained is such a deposit is almost beyond belief. It is considered a reasonable estimate that one acre of drained peat will produce two humdred and fifty tons of dry fuel for every foot in depth. If the Cat-tail would average ten feet thick of workable peat, and this estimate is perhaps below the truth, then an acre would furnish twenty-five hundred tons of dry fuel. The blocks made last summer were almost as dense as bituminous coal, and readily sold for seven dollars per ton or cord. Five dollars could be realized for all that can be manufactured. The price of manufacturing the fuel need not, I think, exceed two dollars and fifty cents per ton. This leaves a net profit of over six thousand dollars to every acre of ten foot peat. At these figures a hundred acres of this best peat land would be worth, as an element to convert into material weath, over six hundred thousand dollars.

Some geologists reckon a ton of well manufactured peat fuel as equal to a cord of dry hickory wood. If this is true, the Cat-tail is indeed a valuable deposit. I sat by a peat fire several frosty evenings, while making my investigations in this part of the county. The fuel certainly made a cheerful fire. It was burnt in a grate; made little smoke; left little ash, and that light and white; there was no unpleasant smell, and a bright flame was given out. It consumed, however, rather rapidly, and as a generator of heat is not equal to the better varieties of coal, or the harder varieties of dry wood.

And yet, after all this apparent fair showing, some caution ought to be exercised in the investment of money in this new enterprise. The great labor of handling the raw material must ever make the cost of manufacturing peat bricks a considerable item of expense. The Rock Island coal fields are at no great distance, and for many years will cheaply furnish a good article of Illinois coal. The cost of peat machines is quite an item, and experience may encounter unexpected difficulties as further progress is made in the work. I simply throw this out as a doubt in my well-grounded faith in the final and complete success of manufacturing crude peat into a cheap and valuable fuel. For coking purposes, and for the working of iron and steel, it is said to furnish a heating material more valuable than any now in use.

The principle of manufacturing the fuel, now being applied in the Cat tail mills, is essentially that of WEBER. The crude peat is ground by cutting arms, revolving in a strong box, between fixed arms. When the texture or fiber is destroyed, it is molded into convenient sized blocks; some of the water is squeezed out; it is then dried a few days or weeks in the sun, and eventually is cribbed like Indian corn in covered narrow plank cribs. Condensation is chiefly effected by a destruction of the fibrous texture, permitting the peat, when it dries, to contract into a more solid form. Compressed peat, or peat made by an attempt to press or squeeze the water out, no matter how powerfully the pressure is applied, will not succeed in making the pressed material either dry or solid. Good peat is very elastic. When the pressure is removed it returns to nearly its original volume. The partial closeness of texture given to the outside hinders the drying process. Actual experiments have taught the manufacturers this truth, and they have abandoned the idea of pressing the water out by mechanical means.

A cord of wet peat, by the natural process of drying, shrinks to one-third or one-fourth its original size. Condensed into the solidity of ordinary coal it shrinks much more. This loss of bulk and weight is caused by the evaporation or loss of the water contained in the peat. The great desideratum is to get rid of this large amount of water as economically and with as little handling as possible. New processes of manufacture, new applications of labor-saving machinery, and cautious but liberal outlays of capital, will yet overcome every difficulty now in the way; and as the wants of the human family require new supplies of fuel, the bogs and marshes will furnish it, as the barren hills now spout forth their treasures of oil.

The peat furnished by the Cat-tail deposit is of excellent quality. It contains few veins of sand, mud, or other impurities. When first dug the blocks have a dark, almost black color, and an unctious or greasy feel. When dry, it becomes comparatively light, has a fine, spongy, fibrous structure, and compares favorably with dry peat blocks from the heather-clad moors and heaths of Scotland or the Emerald Isle. The Sphagnum mosses are the true peat producers; but in our Western sloughs, swales, marshes and bogs, grasses, sedges, and other species of aquatic vegetation contribute largely in making up the beds. Grass peat, when old, thick, and subjected to pressure, makes a solid, lusterless, dark-colored peat; moss peat, under the same circumstances, is a little more fibrous in texture; both growing together make a modified peat. In the Cat-tail and other similar sloughs, the ground is covered with a short, thick, velvety moss, out of which rises a dense vegetation of grasses, sedges, and rushes. The ground has a quaking tread; is saturated with water; and the heavy vegetation, as it settles down, becomes perfectly soaked and even covered with water. The mosses keep dying at the roots and growing at the tops. The antiseptic peat water arrests rapid decay. From this slow decay, by chemical action, solid compounds are formed able to resist decay. The mass grows, and a peat bed is the result. Pile a mountain upon this highly concentrated vegetable matter, sink it beneath the ocean's level, and cook it, or season it for a few millions of years, and a bed of coal would be the result.

It will thus be seen that moisture and a low temperature are essential to furnish favorable conditions for the growth of peat. In the dry sandy soil of Winnebago county, for instance, little peat can be found; in the swamps and marshes of Whiteside county it is found in all stages of growth and ripeness. The Cat-tail is a ripe, fat, and old deposit. I will now pass to some of the younger and more unripe beds.

In the Maredosia slough I heard of some peaty deposits, but did not examine them. They are probably not of much value as a fuel.

South-west of Prophetstown there is a peat marsh known as "The Big Slough," extending from near Rock river in a south-east direction until it loses itself in the Winnebago swamps. Its average width is nearly half a mile. I spent a day boring in this great deposit with the peat augur. In thickness the peat is from four to nine feet. A foot or two of fibrous turf covers the top of the marsh. Alternating layers of a coarse, red, unripe peat, and veins of mud and sand and other earthy substances were observed at every boring. Silver-shining threads and fibers show themselves in the good peat. They result from the partial decomposition of coarse, wirey grasses. The deposit, and several stages of its growth, seems to have been overflowed by water. At each flooding earthy matter and sand was swept over the slough and deposited as a sediment. At present a heavy growth of Sphagnous mosses is flourishing in the greatest profusion over the whole slough.

This great slough, for the reason stated, is not so valuable for fuel making as the Cat-tail; but for fertilizing purposes it is perhaps better.

Many less valuable deposits of peat exist in the low-lands towards the Winnebago swamps; but I deem a minute description of them unnecessary at this time. I cannot leave this swampy region, however, without noticing a curious phenomenon often seen among them. I refer to the sand-hills, sand-dunes, sand-blows, or "blow outs," as they are called in the common speech of the people. The wind has built the sand into curious-shaped, ever changing hills. The "blow out," about twelve miles south of Sterling, is a circular range of low sand hills, inclosing a small lake. It looks like the extinct crater of some old volcano, but owes its peculiar shape simply to the action of prairie winds.

The Sphagnus mosses and the highly concentrated cooked vegetable matter of these peat beds, in chemical composition, are similar to the woods of our forest trees. Where pure, ripe, and fat, this peat can readily be converted into a cheap and valuable fuel—valuable as a clean, healthful fuel; valuable, on account of its strong flame and freedom from ash and clinker, as a steam generator and locomotive driver; valuable, on account of its freedom from sulphur and other metalic impurities, for working iron and steel; valuable, for its fine coke producing qualities, and the many other economic uses to which it can be put on account of its fine heating properties; and cheap, because the supply of raw material out of which the fuel can be manufactured is inexhaustible.

The youngest, unripe qualities may be put to use as a fertilizer and a valuable addition to the poorer prairie and hill soils. For this use it is almost invaluable. Gein or humus is the fertile element in all soils. It is also the life of stable and barn-yard manures. This is so well understood in the New England States, under the scientific investigations of their agricultural chemists and geologists, that peat, and even the pond mucks and muds, are every year composted in large quantities, and spread over the thin soils, with the happiest results.

Agricultural chemistry has demonstrated, that the salts and gein of a cord of wet, raw peat are equal to the manure of one cow for three months. Practical agriculture has also demonstrated that crude peat, in its raw state, is too acid and sour to be immediately beneficial to the soil. By composting for a few months with wood ashes, lime, potash, or common manure, the whole mass becomes sweetened, and one of the best and strongest fertilizers for farm crops is produced. The orchard, the vine, and the garden fruits feed greedily upon this compound, and bear abundant crops.

When necessity compels our prairie farmers to turn their attention to fertilizers, these unripe peat beds will become the most valuable spots on every farm. Tracts of sterile land in Maryland, worth but four or five dollars an acre, suddenly increased in value to forty dollars an acre, upon the discovery in their neighborhood of the wonderful fertilizer, the green marls of Maryland and New Jersey. A peat bed is not only valuable itself, but will eventually confer a new value upon all adjoining lands, if properly used.

Clays, Sands and Soils.—Further remarks upon the clays, sands, and soils of this county, and their products, seem hardy necessary. The discussion upon these topics in the Ogle county report might be applied with nearly equal truth to this county.

Antiquities.

I cannot close this report without referring briefly to the antiquities left by the mound builders. Near the Niagara limestone quarries above the city of Sterling, on a high table land overlooking Rock river, from the north bank, is a large congregation of these mounds. Along the south bank of the river, below the city, many large ones are scattered along. Most of these Sterling mounds are the common round ones. Their size is a little larger than the average. A few oblong ones were noticed, but none of the strange effigies and mystic representations observed at some other localities. Mounds also exist about Portland, and many other places along Rock river.

Many of these mounds have been partially excavated, and some trinkets and pieces of charcoal taken therefrom.

These are commonly believed to be burial mounds; but there is reason to think that many of them are house mounds, or hut mounds, made by covering some sort of supporting structures with sods or surface earth, for winter residences of extinct races of men. The charcoal found in them would indicate the fires once kindled, perhaps, in the center of these low, earth-covered huts. The fact that the mounds are composed of surface soil, with no depression near them, indicates that the materials of which they are composed were gathered from the surface of the earth. Later generations have doubtless used these structures as places of interment for their dead. Whether used as human habitations, burial mounds, memorial or sacrificial monuments; whether built by the Indian tribes, or races of men older than they, may remain a mooted question. The researches of antiquarians and archæologists may yet throw a flood of light upon these interesting investigations. The red man was doubtless a mound builder, but I think more primitive men than he built many of our mounds. In these structures he may have buried his dead, but older and higher civilizations than the red man's, built earthworks for defense, boundaries, and national purposes long before the Indian roamed over these hunting grounds.

The usual flint arrow heads, stone axes, and other stone implements, though not abundant, are sometimes picked up.

One relic was found a few years ago, in the banks of the river at Sterling, which deserves more than a passing notice. The implement is, I believe, of pure copper, fashioned into the form of a long, heavy knife. The broad end has a hole through it, and is turned over from the edges towards the center, making a place or socket for a wooden handle or spear-shaft. The blade is eleven inches long; it is nearly an inch and a half wide near the heel of the cutting side; from thence it tapers on both sides to a blunt point. It has a vein-like appearance over it, caused by the unequal decay and eating of the copper rust. It was found some seven feet below the surface of the earth, sticking out of an embankment which had caved into Rock river. The formation was a dark colored diluvial, or river drift, made up of black or dark-colored deposits, containing chert and considerable river gravel. The spot where found is seven or eight feet above ordinary water mark. If found where indicated, this relic is older than the historic period, and is in some way doubtless connected with the ancient mining of the Lake Superior copper mines.

Prior to the wearing away of the Cincinnati shales, where the Sterling rapids are now located, the bed of the river was higher, and the rapids further down the stream. At that time the stream might have formed the embankment where this primitive knife or spear-head was found; but even that view of the case makes it almost of pre-Indian origin.*

The bone from the fore leg of the Mastodon, found in Ogle county, and referred to in the report of that county, was found in the same river gravel or drift, and at the same depth below the surface. This fact seems to indicate that the Mastodon and the maker of this copper knife existed at the same time in the Rock river valley.

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*NOTE.—This knife has been figured in the Transactions of the Chicago Academy of Science, Vol. 1, plate 23, fig. 3. A. H. W.

CHAPTER X.

BUREAU COUNTY.

This large county is located in one of the finest agricultural portions of the State. It is bounded on the north by Whiteside and Lee counties, on the east by LaSalle; on the south by the Illinois river, and parts of Putnam and Stark counties, and on the west by Henry county. The Illinois river also touches the south-eastern boundary line for four or five miles, and the south side of the township of Milo joins upon the north side of Marshall county. The county is longest from east to west, being six townships, or thirty-six miles. It is four townships, or twenty-four miles from north to south, except where the township of Milo extends south of what ought to be the southern line. There, of course, the distance is six miles more. The county thus contains about twenty-three and one-half townships, or eight hundred and forty-six square miles or sections of land.

The general configuration of the face of the county; its groves, streams, soil and other characteristics, are similar to those of Henry county, with the exception of some peculiarities along the Illinois river. The prairies are not quite so rolling as those of Henry county. The timber skirts the streams more in belts, and fewer groves stand like islands over the expanse of the prairies. The surface of the ground rises and falls in long, swelling undulations, separated in places by level stretches of country. The streams wind in long curves. The soil is light and warm. Corn and the grains, grasses, fruits, potatoes and the other staple products of Northern Illinois grow luxuriously, and are almost never failing.

Streams.—Green river enters the county about twelve miles from its north-west corner, flows south with very crooked windings through the township of Greenfield; then turns westward through the north part of the township of Gold to the west county line, cutting off from this corner of the county the township of Fairfield and parts of the two townships just mentioned. Green river has here its usual characteristics. These three townships have in them large bodies of genuine Green river swamp lands. Big Bureau creek comes in from Lee county near the north-east corner of Bureau. It flows in a general south-west direction to a point a short distance west of the city of Princeton; from thence it takes a south course for ten or twelve miles, and then turns nearly due east and falls into the Illinois river some five miles from where the south boundary line of the county strikes that river. This stream has very little alluvial bottom land along its course. The prairie rises in rather abrupt swells from the banks of the stream. About Tiskilwa and on to the Illinois river there is an alluvial bottom, covered with a dense growth of timber.

West of Little Bureau creek is a tributary of the former, rising in the northern part of the county and forming a junction with the larger stream a few miles south-west of Princeton. It is a smaller stream, but of the same general character.

Brush creek and Coal creek are small prairie streams, the latter flowing near Sheffield, and losing itself in the Green river swamp land.

On the south east corner of the county, the Illinois river forms the boundary line for a distance of some fifteen or sixteen miles. There is a broad alluvial bottom along this river on the Bureau county side. The lowest bottom is mostly a swampy, grassy plain, interspersed with sloughs, and ridges of river sand, and subject to inundations when the Illinois river sends out its floods over the low banks. One of these sloughs assumes the character of a lake, communicating with the Illinois river at its southern terminus. The town of Trenton is built upon the west side of this lake, half a mile or more from its outlet into the river. At ordinary or high stages of water, steamboats enter this lake slough, and make their regular landings at Trenton. I shall have more to say of this valley when describing the geological formations of the county.

Timber.—Along Green river there are a few scattering bunches of rather scrubby timber. Big Bureau has a scattering belt along its margin for a considerable portion of its course above Princeton. Below that city it enters a timbered region. The townships of Princeton, Indian Town, Arispe, Lepertown, Selby, and Hall, in the south and east portions of the county, all have considerable tracts of timber. Those below Tiskilwa, and bordering the Illinois river, are bluffy, and mostly covered with a scattering growth of such trees and brush as may be found in similar localities in the northern part of the State.

Big Bureau Grove, in the western part of the county, has a considerable body of timber.

Crow creek, in the township of Milo, and Pond creek, west of Tiskilwa, two small streams not named above, have each some scattering trees along their courses.

"Dad Joe's Grove," in the north-western part of the county, is a small grove on a very high elevation, and is a conspicuous land-mark for a long distance over the prairies.

These groves and timber belts furnish a fair supply of timber, and add variety to the landscape.

The rest of the county is prairie land, some of it level and some undulating and rolling. The two northern tier of townships, the western and south-western townships, and the north parts of Hall, Princeton and Selby, are such prairie lands.

The water sheds between these streams rise to a considerable hight in places, but I had no means of ascertaining how high. The dip of these water sheds and the elevation of the different parts of the county above some given point, as for instance the waters of the Illinois river, would aid materially in fixing the true horizon of some of the coal seams to be spoken of hereafter.

Geological Formations.

No county in this part of the State presents so poor an opportunity for the investigation of its geological formations. With the exception of the Illinois river bluffs from Trenton towards Peru, in LaSalle county, and a small ravine or two near Tiskilwa, there is hardly an outcrop of a single rocky formation in the county. The Chicago, Burlington and Quincy railroad traverses the entire county diagonally from the north-west to the south-east corner, a distance of about forty-five miles. With the exception of a few gravel beds and clay banks, its excavations present no sections of interest to the geological examiner. The Rock Island and Chicago Railroad traverses the southern part of the county through its roughest portions, from the west to the east line, and the same may be said of it. Green river, in this county, has no sign of an outcrop in its low, swampy banks. Big Bureau, West Bureau, and their tributary brooks, with but a few exceptions, cut into no rocky formations. When the railroads and streams, which traverse and cut a county in all directions, show no natural sections of the rocks, the difficulty of correctly describing the underlaying formations will at once be seen. The following section of the Bureau county rocks and drift deposits is approximately correct. The reasons for giving it thus will appear in subsequent parts of this report.

Ideal Section of Bureau County Formations.

1.	Quaternary deposits, such as drift clays and gravels, loess, and alluvial clays and sands	150	to	250	feet.
2.	Coal Measures, such as sandstones, shales, limestones, soapstone and hard clay	250	"	400	"
3.	Cincinnati group of shales	?		?	"
4.	Galena limestone	?		?	"
5.	Trenton proper, or Blue limestone	?		?	"

Commencing with the top, I will describe these formations in the order of their succession. The descriptions are made from the best examinations I was able so make.

QUATERNARY DEPOSITS—*Alluvium.*—The Illinois river bottom, on the west side of the river, lies in the county of Bureau from three miles below Peru to the south line of the county, a distance of from fifteen to eighteen miles in length. At its upper end it is not much over a quarter of a mile wide; at its lower, it gradually spreads out to a mile or mile and quarter. For most of this distance there are two bottoms. The first and widest is a low flat expanse, composed of sloughs, river sand beds, finely comminuted black mud banks, boggy and mucky meadows, covered with a dense growth of wild grasses, and green scum-covered ponds, starred with water lilies. Most of this first bottom is subject to the annual overflows of the Illinois river. Very little of it is susceptible of cultivation, but where dry and high enough to be cultivated, it yields immense crops of Indian corn. The slough or lake on which the village of Trenton stands, runs up along the west side of this bottom for several miles. For part of this distance a heavy belt of bottom timber skirts the Illinois river. Some of the bogs, morasses, and sloughs in this low bottom, covered with green scum and almost seething beneath a summer sun, have a Stygian smell, and must be prolific breeding places for agues and intermittent fevers. The name Lepertown, applied to the part township lying along the Illinois river, is no misnomer.

I do not know the depth of this black, alluvial deposit of river mud and sand, but it is quite deep, perhaps thirty or forty feet in many places.

From forty to fifty feet above this first bottom of the Illinois river, and lying along its western bluff range, is another or second river bottom or terrace. This one is from a few hundred yards to half a mile or more in width. It seems to be composed of sandy and marly clays, intermixed in places with marly-mixed gravels. It is a regular river terrace. Its eastern line is the old shore of the Illinois river. The railroad track is built along this river shelf or terrace, and the traveler, from the car window, obtains a fine view of the valley of the river, stretching away with its dark serpentine belt of timber, and glimpses of the slow-moving, shining water. In the diluvial epoch, when the water spread all over the low bottom, the Illinois river, lake like in its expanse and slowness of current, must have presented a body of water larger than the Mississippi in its ordinary or even high stages of water.

The lower valley of Big Bureau creek has also a narrow alluvial bottom, back a few miles from its confluence with the Illinois river. This bottom is narrow, crooked, and covered with timber. The deposit is a rich, fat, marly one. A few small farms are opened in it below Tiskilwa. These farms are immensely productive.

The swamp lands of Green river are also alluvial deposits. They are grassy marshes and imperfect peat moors and bogs, containing great beds of black mud, muck, and impure peat.

The Loess.—The Illinois river bluffs, already referred to, are partially made up of an imperfect loess deposit. These bluffs rise to a hight of nearly one hundred and fifty feet, and display some of the characteristics of the bluff or loess formation. The deposit is not as plainly marked, however, as the marly, partially stratified clays and sands along the Mississippi bluffs, about Fulton. Some of the steeper bluffs present bald knobs, and light-colored marly clays exist along their sides. Between Bureau Junction and Peru there are several places where landslides have taken place, and the formation is more easily recognizable. One of these is a marked feature in the landscape. At a distance, it presents the appearance of a heavy outcrop of a white sandstone. A closer examination shows it to be a heavy bed of sliding, crawling sand. It is a white, yellow-banded sand, marly in its composition, and exhibits the most marked lines and bands of stratification. The outcrop is about thirty feet in thickness. It may be found in the side of the bluffs, near the railroad track, some three miles east of Trenton. The caving sands have crawled down the hill almost to the railroad track.

This loess formation thins out rapidly as it recedes from the bluffs, and soon loses itself among the drift clays, with which it is closely associated. These bluffs, for a part of the distance, in this county, show no rocky outcrops along their bases or up their ravines, but are mostly made up of loess and drift-clays, and sands.

Drift.—The usual yellow and blue clays of this part of the State lay over this county in a thick deposit. The artesian well, at Princeton, shows them to be about seventy-nine feet thick there, before rock was struck. The record of that well shows that a thin bed of rock was then struck, only three feet thick, and then a hard-pan clay was penetrated to the farther depth of one hundred and fourteen feet. There may, however, be some mistake about this; the record was poorly kept. It is more likely that the thin bed of rock was some detached mass sticking in the drift clay, and that the real depth of these clays here is about one hundred and ninety-three, instead of seventy-nine feet.

Some of the higher ridges of the prairies contain finely assorted gravel beds. This is true of that portion of the county between Sheffield and Tiskilwa. Some fair gravel beds are also opened along the railroad northeast of Princeton. But these gravels are full of marly clays and hard-pan. No coarse gravel beds and fields of boulders were noticed. Some detached boulders of black and flesh-colored granite were noticed at a number of places on the surface of the prairie. No beds of heavy coarse gravel were observed. The regular drift deposits of the county belong to the lower and older drift clays. I could observe nothing like glacial action, and the only evidences of the ice forces are the boulders dropped from the icebergs floating over the submerged prairies.

Coal Measures.

On all the old geological maps of the State which I have seen, the northern line of the Illinois coal field is marked too far south, both in this county and in Henry. According to these maps, about one-half of this county—the north half—is underlaid by Silurian rocks. The north boundary line of the Illinois coal field should commence at a point in the east line of Bureau county, ten miles south of the north-east corner of the county, nearly due west of Homer Station, on the Illinois Central Railroad. Thence it should be drawn nearly due west, but curving or bellying a little to the south, until it crosses the track of the Chicago, Burlington and Quincy Railroad, a little south-west of the village of Malden; thence it should bear off a little north of west until it intersects Green river at the north-east corner of the township of Gold; thence down Green river to a point north of Geneseo, in Henry county; thence north-west until Rock river is reached, a few miles above Aldrich's mine, touching and taking off a small corner of Whiteside county. All of Bureau and Henry counties south of this line are underlaid by lower Coal Measure deposits.

A line passing through the points where coal is actually worked along the north margin of the Illinois coal field, would pass across the State from Rock river to the Illinois, as follows: Commencing at Aldrich's mine, on Rock river, thence south-east to Anawan, on the Chicago and Rock Island Railroad; thence nearly east on the same road to Sheffield; thence to the shaft of Robinson, Dinks & Co., near the crossing of the railroads between Wyanet and Buda; thence north of east to Bierman's shaft, five miles east of Princeton; thence to the shafts and outcrops about LaSalle and Peru. Coal may yet be worked north of this last line, but at all events, the coal deposits extend as far north as the first described line.

It will thus be seen that over two-thirds of the county is underlaid by the Coal Measures. Having given their superficial extent, let us next obtain as good a vertical section as we can. Two artesian wells, one put down at Princeton and one at Tiskilwa, afford the best opportunities of making such a section. These wells are not always reliable, but they furnish the best data that can be obtained in this county:

Section of Artesian Well at Princeton.

1.	Soil, and yellow and blue clays	53	feet.
2.	Sand	20	"
3.	Clay, indurated hard-pan	3	"

4.	Stone—quality not given	3	feet.
5.	Clay, called hard-pan in record	114	"
6.	Quicksand	13	"
7.	Hard-pan and stone	10	"
8.	Gray sandstone, bottom hard	58	"
9.	Soapstone, bluish-buff color	12	"
10.	Thin mud vein, about	1	"
11.	Sandstone	12	"
12.	Hard rock, which cut tools	14	"
13.	Soapstone, of light color	?	"

The bed of soapstone at the bottom had been penetrated to a considerable depth, and the work had then been suspended. Contrary to general expectation, this well penetrated no coal-seam. The boring is to be resumed for the purpose of trying to obtain a supply of water for the city.

Section of Artesian Well at Tiskilwa.

1.	Earth and soil	6	feet.
2.	Hard sandstone	40	"
3.	Brown clay	25	"
4.	Vein of sulphur	⅓	"
5.	Light colored slate	2	"
6.	Black slate	1½	"
7.	White limestone	4	"
8.	Clayey soapstone	4	"
9.	Hard flinty rock	4	"
10.	White and black slate	1	"
11.	Soapstone	8	"
12.	Limestone	6	"
13.	Sandstone	7	"
14.	Alternating soapstone, sandstone, slate, and clay	40	"
15.	Flinty vein	½	"
16.	Alternating sandstone and greasy clay	6	"
17.	Black slate and flinty vein	3½	"
18.	Fine white clay	2½	"
19.	Coal	1½	"
20.	Fire clay	1	"
21.	Clayey soapstone	5½	"
22.	Light-colored limestone	6	"
23.	Hard clay and sulphuret of iron	5	"
24.	Yellow soapstone	6	"
25.	Shale, color not kept	3	"
26.	Alternating shale, slate, etc	16	"
27.	Clay seam	1	"
28.	Strata of flint. ?	⅓	"
29.	Clay soapstone, etc	2½	"
30.	Hard clayey sandstone	12	"
31.	Softer sandstone deposit	13	"
32.	Brown stone	4	"
33.	White soft sandstone	?	"

This well was bored for oil, at a time when the oil fever was at its hight. Some indications of oil in a spring near by caused the enterprise to be undertaken. Of course, the hoped-for petroleum was never struck. The general similarity between this and the Princeton section will at once be seen, after the rock formations are reached. The heavy, hard sandstone, where the similarity commenced, is, however, struck six feet below the surface at Tiskilwa, and nearly two hundred and sixteen below the surface at Princeton. The latter well, however, was commenced on the upland prairie; the other in the bottom of a deep ravine, with the Tiskilwa coal mines in the sides of the bluffs above the level of its mouth.

Outcrops of the Coal Rocks.—Natural outcrops of the rocky formations are very rare in this county. No county yet examined by me shows so few.

Coal valley is a little valley coming in from among the Big Bureau bluffs from the south just above Tiskilwa. A ravine about two miles in length comes into this little valley from the west, about one mile and a half from its mouth. This ravine is known by the name of Rocky Run. A little stream tumbles down among the rocks and boulders with a very rapid descent. The only stone quarry in this part of the county is in the bed of this tumbling stream. Huge masses of a hard, sub-crystaline, quartzose sandstone block the ravine in places. Considerable stone for foundations, and other economical uses, have been quarried and blasted from these masses. They are not *in situ*, and are not the natural outcrop of the formation to which they belong, but seem to be outliers detached from the parent strata, which are undoubtedly *in situ* under the clay bluffs on either side. These large outliers are somewhat water worn. Among them are many large erratic boulders of granite, trap, hornblende, and quartz. One or two of the granite boulders are very micaceous. A coal seam, one foot thick, outcrops in the midst of these large detached stones, underlaid by a heavy bed of blue plastic soapstone. A section made in this little run showed the following approximate figures:

Section half way up Rocky Run.

1.	Bluff clays, yellow and buff	40 to 60	feet.
2.	Gravelly clay, full of boulders and blocks of sandstone	15	"
3.	Coal, stained with iron	1	"
4.	Blue, silvery, unctious soapstone	10	"

The bottom of this soapstone is still a good many feet above the mouth of the artesian oil-well, whose section has already been given. I have called this outcrop a sandstone; but some of its outliers, especially farther up the ravine towards the barn of Mr. Whiting, present the characteristics of a limestone. The rock is entirely unfossiliferous so far as I could see. A good specimen of *Lepidodendron* was found in this ravine a few years ago, according to local report. In geological interest and picturesque scenery this little run is an interesting spot. I shall speak of its coal seam hereafter.

The next outcrops worthy of attention were found in following the Illinois river bluffs from Bureau to Peru. About two and a half miles east of the village of Trenton, along the base of the bluffs, which rise here to a bold hight, the outliers of a rocky formation first begin to appear. On the farm of a Mr. Dustin, not far from where Nigger creek comes down through the bluffs, stone is quarried to some extent for building purposes in Trenton and on adjoining farms. The stone is a hard, sub-crystaline rock, similar to that outcropping on Rocky Run. In some places it resembles a quartzose sandstone.

In the Bureau county bluffs, from Nigger creek to the county line below Peru, good quarries could be opened in many places; but the difficulty of access to them, the sparse settlements in this portion of the county, and the great abundance of stone about Peru and La Salle, have conspired to prevent the opening and working of the outcrops. In some instances the distinction between argillaceous and quartzose sandstone and argillaceous limestone, is hard to determine, and I may be mistaken in the true character of these outcrops at Rocky Run, and about the mouth of Nigger creek. To me they look like a sub-crystaline, clayey sandstone, if such a rock can be supposed to exist.

These are the most important and almost the only outcrops in the county, except the rock strata found in close proximity to the coal seams.

The coal mines at Sheffield, in the township of Mineral, are the oldest and best known mines in the county. There seems to exist here one of those local coal deposits of limited extent, so common all over the northern part of the State. It is irregularly shaped, but would be found about four miles in diameter. Sections 22, 23, 24, 25, 26, 27, 28, 34, 35 and 36, in the township of Mineral, and several sections adjacent thereto, in the township of Concord, are estimated to contain more or less coal beneath the surface.* The Sheffield Mining and Transportation Company are operating several mines about a mile west of the village, and near the railroad track. A low range of hills, facing north and east, rises from Coal creek to the high prairie lying south. Into this low hill several drifts are extended to the south and west. Some of the drifts are inclined planes extending down to the coal. The drifts are driven into the hill about one-half mile. Twenty-five or thirty feet overhead productive prairie farms are tilled. Black shale, soapstone and irregularly bedded, yellow crystaline sandstone (?) compose the roof; not all found associated together, but some in one place and some in another. Over this slate or stone roof is a body of indurated clay. The coal seam is underlaid by a bed of indurated fire clay. This under-clay contains some large nodular masses of limestone, some of them kidney shaped, and some of them round, and all flat. Fine impressions of fern leaves have been found in the roof slates, if the statements of the miners are to be relied on.

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* NOTE.—These apparently local deposits of coal, occurring along the borders of the Illinois coal field, are not detached outliers, but are localities where the coal seams attain their full thickness, and may be successfully worked; while in adjacent territory they become too thin to work, although they may attain their full thickness again within a distance of a few miles. An area of coal land is often pronounced unproductive, on the evidence obtained, perhaps, by a single boring, where the drill may have struck a "horseback," or some other irregularity in the coal seam, while another boring, but a few feet from the first, would have shown the usual thickness of coal. It is by no means safe to pronounce any consideracle area within the confines of the coal field unproductive, on the strength of such evidences as may be obtained by one or two experiments with the drill. A. H. W.

The coal seam itself ranges from four and one-half to five feet in thickness. A thin seam of light colored fire clay runs through the coal seam near its middle; near the bottom some seams of shale also exist in the coal. This fixes the identity of the coal with that mined at Wataga, Galva, Kewanee, and the upper Peru coal. Prof. LESQUEREUX says that the Wataga coal is the same as the middle Peru seam. I have little doubt of the Galva, Kewanee and Sheffield coals being identical with the Wataga seam. The clay and slate partings in the coal are characteristic of this seam. On the old section of the coal seams of the State this seam would belong to coal No. 11; but according to Prof. WORHEN'S reconstructed coal section, as published in the third volume of the Geological Survey of the State, it would belong to coal No. 6.

The following description and analysis of this coal is taken from the Report on Illinois Coal, made by J. G. NORWOOD and his assistants:

Coal bright, hard, compact; fracture inclining to conchoidal, layers thin, and separated with very minute seams of carbonaceous clod, contains a few thin seams of carbonate of lime; slacks on exposure to the weather.

Specific gravity	1 1986
Loss in coking	47 5
Total weight of coke	52 5
	100.0

ANALYSIS:

Moisture	7.0
Volatile matters	40.5
Carbon in coke	47.5
Ashes (white)	5.0
	100.0
Carbon in the coal	53.4

As a matter of general interest I also give the analysis and description of this same coal, made some years ago, by Professors PORTER and B. SILLIMAN, Jr., who occupied the chairs of Analytical and Agricultural, and General and Applied Chemistry, in Yale College, at the time of making the report, from which I take the following extract:

Subjected to a moderate red heat, it yielded in a hundred parts, as an average of two trials—

Volatile matter	29.32
Fixed carbon	64 90
Ash	5.78
	100.00

The specific gravity of the coal is 1 247, giving 2,103 lbs. to the cubic yard. These results are nearly identical with those obtained from a sample of English bituminous coal (Newcastle) recently analyzed by us. The coke obtained from your coal is of a very superior quality, being firm and of high metalic luster.

The amount of fixed carbon is large. It has been repeatedly demonstrated by experiment that the evaporative power of different coals is in proportion to the quantity of this constituent. Your coal is therefore of superior quality for the production of steam. We have used the coal for several days in an open grate, and find it adapted for this use. It ignites readily and burns freely, cracking open as it becomes heated. It burns to a comparatively small quantity of ash, without producing clinker. To test thoroughly the effect of a high temperature on the coal, we burned a grate full of it, keeping the blower on, until it was entirely consumed. In this case, even, the quantity of clinker or fused ash was small.

In all our experiments with the coal, burning it in an open grate and otherwise, it has not contaminated the atmosphere of the room with sulphurous or unpleasant gasses in the slightest degree. Neither do we observe in the coal layers or grains of pyrites or sulphuret of iron. such as are often found in bituminous coals, and are the source of the sulphurous fumes. By this we do not mean to say that your coal contains no sulphur. Sulphur is found in all coals without exception. But we find no reason to believe that it is present in yours in larger quantity than in other Western coals of established reputation.

We have tried your coal in a blacksmith's forge, and have the testimony of practical men to its superior quality for such use. For many purposes it possesses great advantages over more highly bituminous coals. It does not melt and cement, so as to render a frequent stirring of the fire necessary in order to keep up a draft. Neither does it swell objectionably on the fire. This property, and the firmness of the coke yielded, adapt your coal especially to use in founderies and smelting furnaces, for which purpose it may not improbably be used without coking. It is impossible, however, to give a definite opinion as to this without experiments on a larger scale than we have found it possible to make.

From these descriptions it will at once be seen that the Sheffield mines yield a very valuable coal. The analyses differ considerably as made at Springfield and at Yale College; that, however, may be owing to the coal analyzed having been taken from different drifts or different parts of the seam. The coal sent to the Eastern chemists was, no doubt, the best that could be obtained from the mines.

The next coal mine of interest is near the Chicago, Burlington and Quincy Railroad, south of and near the track, and about two and one-half miles north-east of Buda, on section 25, in the township of Concord. A small stream, and a small grove called Bilbenne grove, at this place give variety to the prairie monotony. Coal has been detected all around this little grove, and there can be no doubt but that there is a productive coal patch of considerable extent to be worked out here. This is but about five miles from the Sheffield diggings, in a south-east direction. A shaft is sunk in the bottom of the ravine, and a drift driven into the hill on the principle of an inclined plane. Messrs. Robinson, Dinks & Co. are working these mines, operating a steam engine to raise the coal from the shaft. The shaft is sixty feet deep; the seam of coal from four and a half to five feet thick, and said to resemble the Sheffield seam in appearance and in the quality of the coal. Forty feet above this heavy seam, and twenty feet below the surface of the ground, is another coal seam about two and a half feet thick; but the coal is of inferior quality. The shaft is used in mining coal in the lower seam, the drift for mining the upper one.

Section thirty two, in the township of Center, is said to show evidences of coal, but as no coal mine is worked there, no examination was made of the place.

Following on southeast in the same general course, the next coal of workable thickness is found in Coal Valley and Rocky Run, near Tiskilwa. These mines have been worked for many years. Two or three drifts have been worked out and abandoned. There seems to be three coal seams at this locality. The lower one has only been found in the boring made for an artesian oil well, at a depth of one hundred and fifty-nine feet below the surface of the ground, at the mouth of the well. It has not been worked, and in the present state of coal mining in this part of the State is of no practical value. The seam is thin; access to it is difficult; its existence was only accidentally disclosed by the oil well boring, of which a section has already been given.

The next seam, called by the miners the middle Tiskilwa seam, is worked in many places. The mines are about half a mile farther up the stream, on the left bank or bluff of Coal creek; the entrances to the drifts are fifteen or twenty feet above the level of the water in the little brook, and still more than that above the mouth of the oil well. I cannot tell the distance between the lower and middle coal seams here, but judge it to be from one hundred and eighty to two hundred feet. The principal drift into this seam has been worked a long time, mostly by Messrs. Churchill & Shaw; the mine is nearly worked out and is abandoned at the present time. At the time I was there Messrs. Jobling, Sleeter & Snowdon had just completed a new drift a few hundred yards above the old one; had struck the seam at a distance of one hundred and eighty feet under the hill, if I recollect right, and, so far as could be judged at that time, they were opening a very valuable mine. I have since heard that this mine is turning out an abundance of good coal. The seam is five feet thick. It can be easily drained; there is a fair roof of black slate; below there is the usual bed of ordinary fire clay. In some places soapstone takes the place of the black slate roof.

This is doubtless the seam of coal from which the analysis was made by Mr. PRATTEN, while acting as Assistant in the Illinois Geological Survey. The following is his description and analysis;

"This bed is of the same age as the middle (?) workable seam of LaSalle county, and like that bed is frequently interrupted with clay "slips." The portion of the bed examined is on L. D. WHITING'S place. Coal very bright, hard, compact; layers generally thick, and separated with carbonaceous clod, sometimes nearly indistinct; fracture conchoidal.

Contains a very few thin seams of carbonate of lime, with occasional thin scales of sulphuret of iron. Swells but little in coking.

Specific gravity	1.363
Loss in coking	43.0
Total weight of coke	57 0
	100 0

ANALYSIS.

Moisture	7 5
Volatile matter	35.5
Carbon in coke	48.9
Ashes (white.)	8.1
	100 0
Carbon in the coal	57.0

To this I might add that this coal makes a considerable amount of clinker and is inclined to become solid enough to clog the grate. As a steam making coal it is hardly considered so good as that furnished by the upper seam, the clinker from which easily crumbles and runs through the grate. It is however a good coal for general purposes. Its accessibility and the ease with which it can be worked, make it a valuable coal.

Going up Coal Valley about half a mile, the outcrop of the upper seam is reached. It is well up on the hill side; supposed to be from forty to forty-five feet above the level of the middle seam. It might be possible that this so-called upper seam is but another outcrop of the coal just referred to, and that the difference in level is owing to a local disturbance; but I believe it to be a different seam, identical with and belonging to the same horizon with the upper coal at Robinson, Dinks & Co's. shaft, near Buda, and Bierman's shaft, east of Princeton. Messrs. Worthington & Marshall are working a drift at the present time at this place. The coal is from one and a-half to two feet thick. Black slate and shale are found over the coal; the usual fire clay exists below it. The clay bluff overlies all to the depth of about forty-five feet. The coal is softer than the other seam; has a reddish or rusty appearance, and cannot be worked to very great profit. The one foot exposure of coal, near the barn of Mr. Whiting, in Rocky Run, belongs to this seam, and lies at about the same general level. The following section will give a general idea of the Tiskilwa coal seams, and associate exposures, and underlaying deposits.

Section of Coal Seams at Tiskilwa.

Drift clays	40 to 75	feet.	
Black shale	2 to 4	"	
Coal	2	"	6 in.
Clays and shales	40	"	
Coal	5	"	
Alternations of shales, sandstone, etc., passed through in the boring	175 to 200	"	
Coal	1	"	6 in.
Fire clay and clay shale	Thickess unknown.		

No fossils were observed in and about these coal mines, except sections of a flattened coal plant of some kind, found in the roof slates of the upper seam. These fragments had become completely impregnated with sulphuret of iron; they presented a beautiful iridescent appearance, and readily split with the grain of the plant, showing its fibrous texture.

The next important coal mines are at Bierman's shaft, five miles east of Princeton, on section 17, in the township of Selby. Two seams are reached here. The following section will give an idea of this coal deposit.

Section at Bierman's Shaft.

1.	Usual oak land soil and sub-soil	4	feet.
2.	Yellow, hard, ringing sandstone	10	"
3.	Soapstone, clay, shale and other deposits	64	"
4.	Coal—soft, rusty, inferior, No. 7	2½	"
5.	Black shale, clay and sandstone	42	"
6.	Coal—hard, bright, good quality, No 6	5	"

The upper sandstone in the above section outcrops along the banks of the creek a few hundred yards below this shaft. This coal seam dips apparently towards the north-west. The shaft is operated by a common two-horse whim. The mine is a very valuable one, and it will pay to put on a steam engine and work it strongly. Another shaft, being sunk a short distance down the creek, had passed through the upper seam, and had reached the lower sandstone at the time I was there. The deposit, I think, is of considerable local extent, and ought to be more fully prospected. The coal is of excellent quality, fully equal to the Sheffield coal. The seams, I think, are identical. The drifts from Bierman's shaft run north and east a few hundred yards. Like the upper Peru seam, this is frequently interrupted by faults, clay slides and horse backs. These latter are places where the coal gives out for short distances, and is replaced by boulders, nodules, shales and a conglomerate mass of sulphuret of iron. The mines at Coal Valley, in Rock Island county, at Perry's, in Henry, at Tiskilwa and Sheffield in this county, and the upper workings at LaSalle and Peru, all, more or less, have this characteristic feature, but are not therefore necessarily the same coals.

These are the only localities in the county where coal is worked to any extent. There is said to be a thin outcrop of coal on Nigger creek, among the Illinois river bluffs. This would be a few miles east of Bierman's shaft. If coal does exist there, it has as yet attracted no attention. There are several other localities in the county where coal is supposed to exist, but they are not worked, and have not even been thoroughly prospected.

The position to which these seams should be assigned in the general section of the coals of Northern Illinois is not so easily fixed. The lower thin vein at Tiskilwa probably is the same as the lower La Salle vein, being No. 2 of the section; and this is the only place, so far as I know, where a third vein has been discovered in the county. The seam worked at Sheffield; the lower seam at or near Buda; the middle seam at Tiskilwa, and the lower or worked seam at Bierman's shaft, are all identical with each other, I think, and are identical with the upper Peru and La Salle coals. This seam, according to the new section for Northern Illinois, would belong to coal No. 6. The upper seam at Tiskilwa, at Bierman's shaft, and at the shaft of Robinson, Dinks & Co., is probably the equivalent of coal No. 7 of the new section of the Illinois coals. These seams are assigned to the horizons of the La Salle coal seams, not on palæontological evidences; characteristic fossils seem to be scarce at all the localities examined; the coal seams themselves, however, and their associate rocks and shales, seem to justify such classification. The position of the Sheffield coal, near the surface of the ground, and no seam being found above it, would seem to identify it with the upper instead of the middle seam; but its place without doubt, I believe, is with the coals of No. 6 in the section referred to.

The general level of these seams varies greatly. The railroad track at Sheffield is eighty-eight feet above, and at Tiskilwa it is sixty-six feet below the level of the surface of Lake Michigan. Estimating from the position of the coal seams, as compared with the railroad track at these places, there must be a difference in the level of the coal of from seventy-five to one hundred feet, in a lineal distance of some twenty miles, showing a dip of about five feet to the mile to the south-eastward.

SILURIAN FORMATIONS.—There are no exposures or outcrops of the Silurian rocks in this county; but the northern one-third of it is underlaid by these rocks in about the following order:

The Trenton or Blue Limestone.—These rocks outcrop rather heavily at Homer, about two miles east of the Bureau county line, in La Salle county. They doubtless continue the underlying rock west, or a little south of west, along the north line of the coal field, until they sink beneath the Coal Measures opposite to Princeton, and extend northward nearly to the C. B. & Q. R. R.

The Galena Limestone.—This limestone outcrops at Lee Center and near Sublette, in Lee county, and is probably the underlaying rock in that part of Bureau county about and on both sides of Bureau creek, and between that creek and Green river, and north of the Coal Measures, with the exception of some elevated ground about "Dad Joe's Grove."

The Cincinnati Group.—These shales would doubtless be found underlaying the grove just named, and may also underlay small patches in the north-west corner of the county, west of the Green river swamps.

Economical Geology.

Coal.—From what has already been said, in speaking of the coal seams and their outcrops, it will be seen that the coals of Bureau county are an important element of county wealth, and minister largely to the convenience and well-being of its citizens. I have no means of estimating the present amount of coal mined each year in the county. The Sheffield mines have been worked since 1853. Two hundred and fifty thousand tons of coal are supposed to have been mined and sold during that time at these mines. They are being worked extensively at the present time, and their supply is by no means exhausted. Thousands of tons have doubtless been taken out by farmers and land owners, in small quantities at a time, of which no account has been rendered. The coal field actually known to exist here has hardly commenced to be worked over, and may be found to extend much farther east, south and west than is now supposed.

The Buda shaft is worked strong enough to employ a steam engine, and is yielding at the present time a large amount of good coal. Other shafts, in course of time, will be put down here. There is evidence that coal underlies several miles in extent of surface around the grove where the present mine is worked. The necessities of the country, and the ease with which shafts reach this good workable seam, insure more extensive operations at this locality. By the Buda shaft I refer to the one between that place and Wyanet.

Almost the same can be said of the locality at Bierman's shaft. I am satisfied this is a valuable field of coal; of considerable extent; of easy access. It will be worked extensively at an early day, and will afford a large supply of excellent coal.

The Tiskilwa coal banks are old banks, having been worked for many years. The amount of coal taken therefrom is not known; but they have at no time been worked as strongly as the mines at Sheffield, and the supply of coal has been much less. I am uncertain as to their future productiveness. For a time they were considered as partially worked out; but the heavy seam found in the new bank of Messrs. Jobling, Sleeter & Snowdon seems to show that the supply of coal is by no means exhausted. This discovery will probably add a new impetus to coal mining in this locality.

There are many other localities in the south western and south eastern portions of the county where shafts sunk to a moderate depth would strike coal from four to five feet thick. Along and among the Illinois river bluffs there is no reason why valuable coal deposits may not be found. Borings along the base of these bluffs ought to disclose the middle and even lower Peru coal seams; and if the ravines were carefully traced to their sources, outcrops and exposures of the upper seam would doubtless be detected under the talus and along the little streams.

Bureau county already produces coal enough to supply in great part the home demand, except a considerable amount of transported coal used in the larger railroad towns.

As fuel becomes scarce, and the demand therefor greater, the coal interests of the county will be more fully developed. The hungry maw of the iron horse; the iron stomachs of many steam boilers; a great increase among the people of coal stoves and coal-burning appliances, will constantly increase the demand for coal. These hidden sources of wealth and prosperity will then be looked up more carefully, and the supply will be found adequate to the increased demand for many years to come.

Building Stone.—So far as at present known stone quarries are few, and the home supply of stone for building and other economic purposes is quite limited. I have already named the localities where stone is quarried, but even at these localities the supply and quality are both of such a nature as to make the quarrying of rock an item of small economic value. Heavy quarries could be opened below Peru, but access to them would not be easy. The difficulty is largely remedied, however, by the ease with which stone from Peru and La Salle, and from the marble quarries of Athens and Joliet, can be shipped on the intersecting railroads to convenient and accessible points all over the county. Lime from the banks of the Mississippi, about Rock Island and Port Byron, and from the stone ledges towards Chicago, is also readily obtained.

Clays and Sand.—The heavy drift deposits over the county contain abundant supplies of sand and the common kinds of clays. Common red brick of good quality can be made at reasonable expense, and sands for mortar dug from almost every township. The facilities for building are thus within the reach of all. No minerals of economical value exist.

Peat.—Several peat beds exist in the Green river swamps in the township of Gold, and in one or two adjoining townships. Some of this peat is of fair quality and of considerable depth. But in the present state of our knowledge as to the manufacture of peat fuel, none of these beds possess very great value for burning and heating purposes. They, together with their associate muck beds, will some day possess a value as a fertilizer of the surrounding prairie soil.

Agricultural and Horticultural Geology.

Enough has already been said about the agricultural resources and capabilities of the county. They do not differ greatly from those of surrounding counties. Perhaps they are better than those of most other counties in this part of the State. The soil seems to have in it a little more fine silt—to be lighter and warmer than that of some of its neighbors. As a consequence of this it is largely and uniformly productive of the staple products of Northern Illinois.

Fruits, and especially the hardier varieties of the apple, do remarkably well. The orchards about Princeton are among the oldest and best in Northern Illinois. According to the reports of the various *ad interim* committees of the Illinois Horticultural Societies, the apple orchards of Princeton are among the best in the State. I know not to what extent grape culture has been carried on in the county; but the nature and properties of the soil would justify the planting of the vine to a large extent. Some of the Illinois river bluffs on the east side of the county could be turned into profitable vineyards. Wine making might be made remunerative in many places where the land is now considered almost worthless. The small garden fruits, such as gooseberry, currant, strawberry, raspberry, etc., do well almost anywhere in this part of the State, and of course flourish luxuriantly in the warm light soil of this county.

EXPLANATORY NOTE.—The geological map of Northwestern Illinois, prepared by Mr. SHAW, to accompany this report, including a section of the formations outcropping on Rock river, was in the hands of the Western Engraving Co., in Chicago, at the time of the great fire in Oct., 1872, and was utterly destroyed. The map is often referred to in the preceding pages. A. H. W.

CHAPTER XI.

HENRY COUNTY.

Henry county is bounded on the north by Whiteside county and Rock river; on the west by Rock Island and Mercer counties; on the south by Knox and Stark counties; and on the east by Bureau county. It is a very large county, being thirty miles long and thirty miles broad, and lying in the form of an exact square, with the exception of about two townships cut off from the north-west corner in a sort of triangular-shaped piece, by Rock river. It consequently contains about eight hundred and twenty-five square miles. The surface of the county is made up mostly of a high, rolling, fertile prairie, in places breaking into rough ridges and ravines. For a few miles back from Rock river, in the north-western part of the county, and about Minersville, the land almost approaches the character of barrens, being interspersed with ravines and elevated ridges, partially covered by a somewhat stunted growth of oak timber. About the north-eastern corner, the prairie becomes somewhat sandy, rising occasionally into white hillocks of sand, cut into picturesque shapes by the prairie winds. Across the northern part of the county, the broad valley of Green river is level, and chiefly composed of swamp lands, of which there is estimated to be some fifty thousand acres. This valley is rather a low, wet, swampy prairie, than a regular river valley. Green river enters the county from the east, about eight miles from the north-east corner, and flows almost directly west across the county, through the second tier of townships, until it enters Rock river, a few miles south-west of Colona. For a part of this distance, it is rather a succession of swamps than a river. At other places, it is a broad sheet of stagnant water, almost lost among the reeds, rushes, and tall grass; but towards its outlet into Rock river, these waters gather into a stream of considerable size and depth, with scarcely an appreciable current—a slow, lazy, stagnant stream, oozing along amid a deposit of black, greasy looking mud—green with its coat of August scum, a very Styx of a stream, on whose filthy, scummy surface intermittent fevers and agues seem to play, like half-concealed, restless ghosts. Such a stream I have never seen before, not even excepting the liquid mud of the Pecatonica, which latter stream has a decent current or flow, when compared with Green river. And yet I would not convey the idea that Henry county is an unhealthy county. The salubrious air of her broad prairies quickly neutralizes any miasmatic influences thrown off by this local nest of fevers. If Pandora's box itself were opened on one of our broad, high prairies, the spirit of Health would drive thence the whole brood of ills and woes and diseases as they swarmed forth. The Edwards river flows across the southern part of the county, in almost the same relative position that Green river occupies in the north. The surface between the two, which is from twelve to fifteen miles wide, is a high, dry, rolling prairie, under a good state of cultivation, the water-shed of the two streams running not far from the middle of it. The Edwards river has a bottom averaging perhaps a mile in width. This is low, but not so wet or swampy as that of Green river. Both streams are almost timberless; the latter almost dries up in the summer season, but when swollen with rains, it is a formidable body of water. The country rises rapidly from the Edwards river bottom, assuming almost the form of a low range of undulating bluffs along its south side. The southern part of the county is of the same general character as that between these two streams, except the south-east corner township of Kewanee, which is somewhat broken, and covered with timber where most broken. Spring creek is a deep little prairie brook, which runs towards the north, and falls into Green river twelve miles from the eastern line of the county. These are the only streams of consequence in Henry county.

In addition to the scattering timber about the north-west and south-east corners of the county, in the townships of Kewanee, Colona, and Hanna, the broad expanse of prairie is diversified by a few beautiful groves, many of them sadly marred by the settlers' axe. Among these are White Oak Grove, south of the village of Andover; Sugar-Tree Grove, east of Cambridge, the county seat; Hickory Grove, not far from Galva; Red Oak Grove, in the township of Weller; a small grove near Council Hill; and several small barren groves, whose names I do not now recollect. These furnish a fair supply of timber for their immediate neighborhood, but will become exhausted in process of time, unless timber-growing receives more attention on our prairies.

In an agricultural point of view, this county is hard to excel. Such a large proportion of the surface is under cultivation, that its grain-producing powers must be immense. Such being the case, wealth, and a high state of prosperity, are found to characterize its citizens.

Its groves; its rolling fertile prairie lands; its remarkable marshes along Green river, being a continuation of the famed Winnebago swamps; its few sand-hills; and its unequalled Green river, are the most prominent characteristics of its surface topography, and do not differ materially from those of adjoining counties north and east.

Geological Formations.

These consist of the usual Quaternary deposits, the lower Coal Measure series, and some low outcrops of the Hamilton and Niagara limestones. The geology of the county at first thought appears quite simple; but the paucity of stone quarries, and workable outcrops, over most of the county, makes the problem more difficult than one would at first imagine The best section I can construct will give the formations about as follows:

General Section of County.

Alluvial deposits and Drift clays	50 to 100 feet.
Lower Coal Measures	250 to 300 "
Hamilton (Devonian) limestone	20 "
Niagara or Le Clair limestone	15 "

In this section a very marked hiatus of Illinois rocks will be observed between the Hamilton limestone and the Coal Measures.

Niagara Limestone.—In the bed of Rock river, where it first touches the north-western boundaries of Henry county, and from thence about half way to Cleveland, the soft, fine-grained, yellowish Le Clair limestone shows itself, and is quarried during low stages of the river, at one place to a considerable extent. The Coal Measures at Aldrich's, and Johnson & Kent's coal mines, rest directly upon this member of the Niagara limestone. Except this limited outcrop in the banks and bed of Rock river, this formation cannot be said to be developed in the county. At ordinary stages of water in that stream, the outcrop would hardly be detected. With the exception of a few encrinite stems, no fossils were noticed in it.

Hamilton Group.—On descending Rock river from the Niagara outcrops, just mentioned, the lower division of the Hamilton limestone is next discovered, commencing in the bed of the river about a mile and a half above Cleveland, and continuing as the river flows to the west line of the county, and thence west at intervals across Rock Island county. A short distance above Cleveland, and two or three times below it, in a distance of three miles, a short axis of upheaval appears to extend from the river almost south across Rock river bottom, which is here three-fourths of a mile in width, and runs under the bluff line. At these places the Hamilton limestone comes to the surface of the ground, where the rains or little streams have removed a few feet of the top soil. These axes, or undulations, rise twenty-five or thirty feet above the low bottom land of Rock river. Between are depressions or troughs, filled with Coal Measure deposits. The heavy seam of coal, worked so extensively at Cleveland, rests in one of these basins, and extends half way across Rock river, resting almost directly on the Hamilton limestone. The top of the axis spoken of above, east and west of the coal basin, is higher by several feet than the coal seam. Southward, however, the Coal Measures continue uninterrupted under the bluffs to Coal Valley, and the Minersville mines.

These natural outcrops of the Hamilton limestone are massive and solid in their structure. The stone breaks with a smooth conchoidal fracture, almost resembling polished marble. On fresh fractures, the color is a beautiful bluish-white or pale dove color. A semi-transparent, splintery, horny appearance was noticed in some cases, on breaking a rock to pieces with smart blows of the hammer. No fossils were observed. Indeed, the lower portion of this rock is almost devoid of organic remains.

While making these observations, parties were engaged in boring an artesian well, two miles above Cleveland. Prospecting for petroleum and coal was the object of the boring. Any practical geologist could have told the proprietors that their hopes would not be realized, and that their labor and money was being foolishly expended. In connection, however, with the geology of this part of the county, they made an interesting hole in the ground, of which the following is the best section I could obtain.

Section of Artesian well near Cleveland.

1.	Black earth, alluvial deposit	12	feet.
2.	Black and dark colored shales and slate	18	"
3.	Dark limestone, cap rock of Cleveland coal	3	"
4.	Limestone (probably Hamilton and Niagara)	398	"
5.	Soft shale (probably Cincinnati group)	77	"

At this depth the drill struck a sharp, hard rock, with sandy grit in it. How much deeper this well was put down I have not ascertained. Another artesian well was put down, just north of Kewanee, to a depth of six hundred feet, in search of water, I believe. No accurate record of strata bored through was kept. Three hundred and fifty or four hundred feet of the bottom penetrated a hard light-colored limestone, being perhaps the same formations passed through in the lower part of the Cleveland well. This, however, is only conjecture.

Coal Measures.

With the exception of the formations just described, the whole county is underlaid, below the usual drift deposits, by the lower Coal Measures. It is quite difficult to obtain a correct knowledge of the local extent of particular deposits, on account of the scarcity of outcrops. In other counties the railroads and the streams nearly always expose the upper rock formations, and give, in their cuts and banks, well marked outcrops. In Henry county, the railroads only afford a few clay cuts, not once exposing any rock formation. The river banks of Green and the Edwards, are, if possible, still more unfavorable for geological examinations. Not once, so far as I know, do the banks or bends of these streams afford good outcrops of even the sandstones and limestones of the Coal Measures. Large portions of the county are utterly without stone quarries of any kind. In a few places fragmentary outcrops of rotten sandstone, or defective shaly limestone, occur; and in a very few localities limestone or sandstone is quarried in abundance. I shall first speak of these outcrops, before attempting to describe and trace the coal seams.

Sandstone.—Overlying the lower coal and its roof of black shales and dark limestone, is a heavy deposit of coarse-grained sandstone. The rock is gritty, not very hard, of a creamy-brown or dirty-whitish color, and greatly resembles the sandstone deposit north of Morrison, except that the soapstone seams are wanting. Three miles below Cleveland, in the face of the river bluffs, but near their base, and at several places below or farther down the river, the outcrop is conspicuous, and has been quarried for local uses. The outcrops are partly hidden by talus; but the sandstone at these localities seems to be from twenty to thirty feet thick. This same sandstone, on a line westward, outcrops heavily at Camden, at Hampton, and opposite the latter place in Iowa. At the latter place, some fine specimens of *Lepidodendron* were found some years ago. The principal outcrops about Cleveland are on sections 20 and 35 of township 17, range 1 east. At Moline it also outcrops, and at Hampton, it covers a thin coal seam or trace of coal.* At Camden, the coal seems to be above the heaviest body of sandstone. At Hickory Grove there is a light sandstone outcrop, not very thick; stone poor quality; quarried by neighboring farmers. In the valley of Green river, up the latter valley, and into the bluffs of Mineral creek about Minersville, the same bed of sandstone shows itself in several places. The outcrops here run from seven to twelve and twenty feet thick. On section 3 in the township of Munson, and not far from Cambridge, some poor sandstones are quarried. In the shaft of the Platt Coal Company, just east of Kewanee, thirty feet of heavy sandstone was struck immediately overlaying the coal seam at the bottom of the shaft, but this bed is about a hundred feet below the surface.† In the vicinity of Red Oak Grove, a thin, rotten carboniferous sandstone has been quarried by the farmers, and used for farm purposes. One well was walled with this material. The wall decayed or rotted down, and the well caved in after it had been in use for a series of years. On section 20, on Spring creek, in the township of Atkinson, there is a small stone quarry, but my notes on its characteristics have been misplaced or lost.

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*NOTE.—We think Mr. SHAW has here confounded two distinct beds of sandstone, that at Camden being below the main coal seam, instead of above it. The sandstone above the coal is a much more durable, and is generally a harder rock than the bed below. A. H. W.

†NOTE.—This sandstone overlies coal 5 or 6 and is at least one hundred and fifty feet above either of the beds outcropping in the vicinity of Camden, Moline or Carbon Cliff. A. H. W.

These are the best tracings I have been able to make of this bed of sandstone. Its place in the geological section of the county seems to be above the heavy, lower, workable seam of coal, sometimes separated therefrom by shales and limestone, and sometimes appearing to rest almost directly on the coal. Its position is by no means constant, however. It is also almost unfossiliferous. A few tracings of *Calamites* and *Lepidodendron* were the only organic remains I could find in this deposit.

Limestone of the Lower Coal.—The "cap rock" over some of the coal mines is a dark-colored, almost black, and sometimes shaly limestone. in which is frequently found a small and beautiful *Productus*. The coal seam at Aldrich's mine is overlaid by a thin stratum of shale, which is capped by a hard, blue, shelly limestone. This limestone is quarried in small quantities here, and sold at a high price to neighboring farmers. At Cleveland, the coal seam is stripped of its superficial covering over several acres in extent. The limestone is more massive here, not quite so dark in color, and rests almost directly upon the coal. Hundreds of cords of it are stripped from the coal. The deposit is from one to two feet thick, and great quantities are sold at remunerative prices. Large numbers of the heavier stones thus quarried are to be used in the railroad bridge to be built across Rock river at this place. Immense slabs, more than a foot in thickness, obtained at the lower opening, are piled over an open space, ready to be transferred to the piers in the river. Some of these show signs of crumbling round the edges, as if the tooth of time had gnawed into their surface. We doubt whether they will prove entirely satisfactory for railroad masonry. Above this massive strata, and separated from it by from four to seven feet of shales and black, hardened carbonaceous mud, is another strata of lighter-colored, thin bedded, shaly limestone, which is also corded up and sold for lighter masonry. The supply of stone thus obtained at these coal mines is very considerable. About Minersville the same limestone is found in connection with the coal seam, and a section here would be very similar to the Coal Valley section, except the sandstone above spoken of.

Along the banks of Geneseo creek, a little south-west of the city of Geneseo, there is a very curious outcrop of stone, which has been worked to some extent in former years. The top of the stratum is a sandstone for about two feet in depth. It then gradually changes into a blue, compact, or dark-colored limestone, having a nodular or concretionary appearance. The whole rests on several feet of compact, hardened carbonaceous mud. But the most curious deposit in this interesting locality is a thin stratum of "cone in cone," outcropping in the yellow clay, several feet above the top of the sandstone. The stratum is from two to four inches thick, has a woody or fibrous texture, the grain running vertical to the plane of stratification; on being dug from the ground it falls into small blocks, having the appearance of wood split from a thin section of a large tree. In one or two of the low, rain-washed hills in that vicinity, I noticed this same outcrop, with no signs of the underlaying rocks. Large quantities of this "cone in cone" have been gathered up for cabinets. Its resemblance to petrifactions of wood is very complete.

The Coal Seams.—In the north-western part of the county there is one heavy coal seam, well developed, and worked to a large extent. In the south-eastern part of the county, and extending up through its central portion, there are two seams, the lower of which is largely mined. Commencing with the former, and at the outcrop highest up Rock river, within the county limits, we find ourselves at Aldrich's mine, on section 24, township 18, range 2 east. The coal is here about four feet six inches thick. It is overlaid by a few inches of dark shale, and this is in turn capped by the thin stratum of black limestone, spoken of above. A bed of ordinary fire clay lies under the coal. The mine is opened into the point of a hill, up a wooded, romantic ravine, about one-half mile from Rock river, which here washes the base of the bluffs. A steam engine pumps out the water, and draws the coal cars up an inclined plane. The drift extends toward the south at a heavy dip near its opening. The mine has been worked for many years. The coal is a bright, moderately hard, thin-seamed coal, with carbonaceous clod between the seams, and vertical markings of carbonate of lime in the perpendicular openings. The following analysis shows its composition.

Specific gravity	1 261
Loss in coking	43.1
Total weight of coke	56 9
	100.0

ANALYSIS:

Moisture	6.0
Volatile matters	37.1
Carbon in coke	49 9
Brown ash	7 0
	100.0

This analysis was made for the State by Mr. PRATTEN, I believe, and gives the general character of the coal in the north-western part of the county. An approximate section at this coal mine gives about the following figures:

Drift clays of bluffs, light color	50 to 70 feet.
Dark, shelly limestone	2 "
Shale and black slate	6 inches.
Coal (No. 1)	4½ feet
Fire clay	10 "

All above the water level of the river.

Half a mile below Aldrich's mine is the drift of Messrs. Johnson & Kent. The upper part and outer edges of the seam here pass into a very solid, shining cannel coal, with smooth surface and conchoidal fracture. Messrs. Johnson & Kent believe the seam is not identical with the one worked at Aldrich's mine. The roof is of soapstone and shale, and there are some indications of two seams, ten or twelve feet apart, but approaching each other under the hill. There is, evidently, some local displacement here, and probably a local separation of the seam, such as is witnessed occasionally in working the Coal Valley seam.

The next important workable locality is at Cleveland. Here, most of the coal is *quarried*, not *mined*. The surface deposits are stripped off, exposing the seam, which is from four and a half to five and a half feet thick. The quality of the coal is similar to that at Coal Valley, except that it is a little better. The ash is not so red, in fact is almost white, and this is probably the better steam coal.

Section at Cleveland, from the top of Rock River Bluffs.

1.	Bluff clays of the drift	50 to 60 feet.
2.	Whitish-brown, coarse sandstone	20 " 25 "
3.	Gravel bed of ochre color	2 " 5 "
4.	Carbonaceous black shale	3 "
5.	Black limestone	2 "
6.	Coal seam	5 "
7.	Fire clay	12 "
8.	Hamilton limestone	Bottom.

Three or four mines are being worked in close proximity to each other. Taylor Williams has a steam engine in operation, and he both strips the seam and runs slanting drifts into it. Mr. Stokes and Mr. Jefferson Taylor also mine to some extent. The basin or hollow, between the two uplifts of the Hamilton limestone, in which this Cleveland coal seam is found, is narrow at the place where the mines are worked, being only a few hundred rods wide, and coming to almost a point in the bed of Rock river. The coal seam widens out towards the south, but becomes thin where it runs under the river bluffs. Still farther south, and about two and a half miles from the Cleveland coal quarries, is the Green River Valley, which intersects the Rock River Valley a few miles below. This Green River Valley, for several miles round Colona, is all underlaid by the Cleveland coal seam. The south slope of the bluff range between Rock river and Green river at this place, where prospected by borings, also shows the seam or traces of it, at many places. The same seam outcrops and is mined extensively on Mineral creek farther south, and at Coal Valley, south-west a few miles. On the Green river bottom—the underlaying rock—the cap of the coal seam is from seventeen to twenty feet below the surface. The seam at Cleveland furnishes one ton and a half of coal to the superficial square yard of its surface. The section there made will give a general idea of the Coal Measures on Mineral creek, farther south, and for the rest of the north-western part of the county. No two sections, of course, would be exactly alike; but the resemblance would be very marked.

The superficial extent of coal lands, underlaid by this coal seam, extending from Cleveland around by Mineral creek, Minersville, Coal Valley, and Green River Valley, so far as now prospected, contains perhaps some forty thousand acres. On a railroad and coal land map, made by the chief engineer of the railroad about to be built along Rock river, some fourteen sections and parts of sections are marked as underlaid by coal in township 17, range 2 east; in township 17, range 1 east, some twenty-two sections and parts of sections are similarly marked; in township 17, range 1 west, some ten sections and parts of sections are marked as containing coal underneath; in township 16, range 1 west, five or six sections are similiarly marked; in the same township and range east, three sections are coal lands; in township 18, range 2 east, some ten more sections are supposed to be underlaid partially by coal. These east ranges are in Henry county; the west ones are in Rock Island county. The Cleveland mines are in township 18, range 2 east. Other sections will, no doubt, be found containing coal in this vicinity. Of course, all the above marked coal lands are not underlaid by heavy coal deposits. Wherever coal or its traces were detected by the engineer in charge—Mr. J. C. ABBOTT, to whom I am under many obligations, for favors extended—the same was marked coal lands on the map. My own personal examinations confirm the general correctness of this map.

The following worked mines in this coal field should not be passed over without notice. On or between sections 17 and 18, township 17, range 2 east, Mr. Shepherd is successfully operating several shafts; on section 22, township 17, range 1 east, Perry's mine is also now in successful operation; Glen's mine, on section 20, in the same town and range, and some mines on section 21, township 17, range 1 east, now are or have been successfully worked. The seam is from four to six feet thick in this group of mines. It has an easterly dip, and appears to be lower at Shepherd's mines than at the mines of Mr. Perry.

In one of these mines, where a drift is driven into the seam, the coal is separated into two bodies, the upper three feet thick, the lower two feet, separated at the outcrop by seven feet of clay parting. These two parts of the seam approach each other under the hill, and unite in a distance of about six hundred feet.

Shepherd's mines are located about two miles south of Green River Station, on the railroad. He is operating two shafts, and driving one drift mine. The shafts are sunk near the base of Mineral creek bluffs. The roof here is stone, same as at Cleveland. The shafts are about sixty feet deep. The coal seam is thickest on bottom or low land, and thins when followed under the hills, same as at Cleveland. One shaft is operated by a steam engine, one by a gin; both have what the miners call a "sump" in the bottom, for convenience in lifting water out of the mines. The drift is an inclined plane, extending from the surface to the level of the coal. The heavy, overlaying sandstone is higher above the coal than at Cleveland. The shafts and drifts both extend into the same seam. The coal is supposed to be stronger and duller in color than that mined at Cleveland. In Shepherd's mines there is a black shale in places below the coal.

At Minersville, the mining was all done by driving drifts into the seam from and near its outcrops. These mines are well worked out. Others may be found, when the demand for coal becomes greater. The competition, at the present time, between Cleveland and Minersville coal on the one hand, and Coal Valley coal on the other, is spirited. The latter has a little, and but little advantage, in the item of transportation to market.

Perry's mines, almost adjoining the latter mines, still furnishes coal in paying quantities. This mine is also reached by drifting into the coal seam. The most noticeable feature here is the basins or "horsebacks," filled with a conglomeration of nodular masses of clay and sulphuret of iron, which are characteristic of this mine. Some of them are several yards in extent.

The seam under Green river and its valley, in the townships above named, contains a great deal of coal; but the roof is poor. This has prevented its being strongly worked.

From what has been said, it will now be seen that there is a large supply of coal stored away in the north-western part of Henry county, for the present and for future generations. The mineral resources of this part of the county will not soon be exhausted, but will, as they now are, continue to be a source of wealth and material prosperity to the county.

Another heavy coal deposit lies in the south eastern part of the county about Galva and Kewanee. Between this and the Cleveland and Mineral creek mines, and over a diagonal strip across the county from the north-west to the south-east corner, which averages from ten to fifteen miles in width, coal has been found in many places. The seams, however, are thinner than at the two corners. Some of the shafts have been abandoned, and some never were worked at all. I propose to briefly notice some of the coal mines discovered in this portion of the county, before describing the important coal mines about Galva and Kewanee.

About one and a half miles north-west of Geneseo, there in an abandoned shaft, where a coal seam from one and a half to three feet thick was found at a depth of about sixty feet. This, I believe, is the old Allen's mine. Indurated clay, limestone and sandstone were all penetrated in sinking the shaft. The coal was of good quality; bright iridescent in color; hard, even fracture, and rhomboidal cleavage. The seam was considered too thin for profitable working.

At Atkinson, the next station east of Geneseo, on the Rock Island and Chicago Railroad, the well dug to supply the large steam mill standing near the depot, passed through a seam of coal three feet thick, and twenty feet below the surface. One-half mile east of this well there is a shaft still worked, out of which has been taken about ten thousand bushels of coal. The seam is here three and one-half feet thick, and twenty-two feet below the surface, and is operated by a horse gin. There is in this locality a good slate roof over the coal, ten feet thick, and it is underlaid by a bed of fire clay.

About four miles north-west of Cambridge, in the township of Oscoe, Mr. A. A. Crane has put down a coal shaft, striking a seam from thirty-two to thirty-six inches thick, at a depth of eighty-seven feet. The seam appears to thin out towards the north and thicken towards the south.

On the farm of Samuel Dixon, in Munson township, eight miles east of Cambridge, coal is mined to some extent, the seam being the same as at Atkinson, and twenty-four feet below the surface. Two miles south of Cambridge, a shaft was being put down, when I was there. A boring previously made was reported to have indicated coal, at a depth which I do not now remember.

Coal is mined in this vicinity about Round Grove, equally distant east from Cambridge and north from Galva, and in considerable quantities. It is hauled in wagons to Cambridge and over the surrounding prairies, and thus finds a ready market at the mines.

In a few more places over this broad strip of country between Cleveland and Kewanee, coal has been discovered; but sufficient has been said to indicate the general character of the seams here mined. I come now to the most extensively worked locality in the county, and perhaps the heaviest deposit of coal within its limits. Galva and Kewanee, both in the south-eastern corner of the county, but a few miles apart, are widely known as coal mining localities; but at the latter place the mines are worked to much the greatest extent. Five or six shafts are put down at Galva, known as the shafts of Messrs. Knox & Co., Cummings, Johnson, Lindsey, and Barnum. The following section, made at one of them, illustrates the character of all. They are in a group, within a radius of a mile or two, and are as much alike as coal shafts usually are, penetrating the same seam, and put down near together through essentially the same formations and superficial deposits.

Section of Galva Coal Mines.

1.	Yellowish drift clay	32 feet.
2.	Hard rock, bottom softer and sandy	12 "
3.	Soapstone, top light color, bottom dark color	14 "
4.	Black or dark colored slate	2 "
5.	Coal, with clay seams No. 6	4 "
6.	Fire clay, about	9 "

The coal here is of good quality, and similar to the Kewanee coal. The seam is probably identical with coal No. 6, of the general section of the Illinois Coal Measures. At Galva the clay and shale partings are not so well marked as at other points, and at some of the shafts indications of cannel coal may be seen along the top of the seam.

At Kewanee, much capital is employed in the coal mining business. During the past year (1867) fifty-three thousand tons were raised here, of which thirty-two thousand were shipped on the Chicago, Burlington and Quincy Railroad to various points, fourteen thousand were used by the railroad company, and seven thousand were used for home consumption in Kewanee and neighborhood. The revenue thence derived, amounted, during the year, to over one hundred and forty thousand dollars. The productive mines are within a radius of three miles north and east of the town. Within this small area, some eight shafts have been put down, and twenty drifts driven in. The shafts are sunk from the general level or face of the country; the drifts are driven upon the outcrops in some deep ravines, passing up from a good sized brook three or four miles north of the town. The face of the country, among these mines, is rough, and covered with a scattering growth of barren, oak timber.

The shafts are operated by the following companies and individuals: The Platt Coal Company, Messrs. Walker & Co., Breckens & King, McCartey & Kirby, K. Murchison, J. C. Bowerman, H. Martin, W. S. Carnly, and one or two others of less note. Of these, the Platt Coal Mining Company, whose mine embraces about one thousand acres of land, located one mile east of the village, does by far the largest business, and by some arrangement handles and markets all the coal dug in all the mines in this vicinity. Their shaft is near the railroad track, and they have a very convenient mode of loading the coal into the cars. At the depot, there is also a large elevator-shaped building, used for the purpose of feeding passing locomotives with their supplies of coal.

A section of these mines, made at the Platt Coal Company's shaft, is as follows:

1.	Soil, subsoil and yellow clay	5	feet
2.	Oily looking quicksand	20	"
3.	Soapstone, light and dark color	25	"
4.	Upper coal seam No. 7	2½	"
5.	Fire clay	10	"
6.	Soapstone	?	"
7.	Sandstone, same as at Galva	30	"
8.	Middle coal seam No. 6	4½	"
9.	Alternating soapstone and sandstone	80	"
10.	Carbonaceous shales and coal traces (No. 4 ?)	A few inches.	

The four and a half foot vein is the same as the Galva seam, and is, probably, indentical with the upper seam at La Salle, and with coal No. 6 of the general section of the State. The upper seam, some forty-two and a half feet above the lower, is perhaps No. 7 of the same section. The lower eighty feet of the foregoing section was prospected by boring an artesian well in the bottom of the Coal Company's shaft, and ought to be regarded with some doubt as to whether it shows correctly the indications of coal in the bottom. The bed of quicksand or shifting sand, No. 2 of above section, was struck near the depot, in a shaft now abandoned.

The supply of coal at Kewanee and vicinity is very large, and will not become exhausted for many years. Newly discovered mines will replace those worked out, and the revenue derived from this deposit of mineral wealth will build Kewanee into a place of consequence.

In NORWOOD's report upon Illinois coal, I find a description and analysis of cannel and bituminous coal, taken from the same seam, at a place then called "Serrell's mine," which it may be well to insert, in this place, for convenience of reference:

Serrell's Mine, Kewanee.

"Thickness of the bituminous portion of the bed, four feet, underlaid with fire clay. Coal bright and dull in alternating layers; hard, compact fracture tolerably even. Contains thick seams of carbonate of lime, which cross each other at nearly right angles, causing the coal to break into slightly irregular cubes. Has sulphuret of iron disposed both horizontally and vertically. The layers of coal are thick and separated with carbonaceous clod. Coke very bright and good, but swells in coking.

Specific gravity	1.232	
Loss in coking		42 2
Total weight of coke		57 8
		100.0

ANALYSIS:

Moisture	9.0
Volatile matter	33.2
Carbon in coke	52.8
Ashes (gray)	5.0
	100 0
Carbon in the coal	52.2

Cannel Coal in same Seam.

Thickness of the bed from eight inches to one foot, overlaid with black slate; underlaid with four feet of bituminous coal. No analysis of this coal has yet been made; but judging from its texture and general appearance, it does not differ from the Wataga cannel coal. The coal is dull, hard, compact, fracture slightly conchoidal; layers thick; contains bright, yellow, vertical plates of sulphuret of iron."

NOTE.—While engaged during the past spring in examining the coal deposits of Rock Island, I was induced to extend my examinations into Henry county, in part to confirm observations previously made in adjoining territory, and partly to satisfy myself as to the general development of our workable coal seams along the north western confines of the Illinois coal field.

Commencing at the north-west corner of the county, coal No. 1 of the Illinois river section is opened and worked at various points in the bluffs of Rock and Green rivers, as at Cleveland and near Colona, as shown by Mr. SHAW, in the sections given on the preceding pages, and it presents the same general characters here as at Carbon Cliff, Coal Valley, and other points in Rock Island county. It is overlaid by a peculiar dark-gray silicious limestone, and its accompanying band of flint or chert, that enables any one to identify it without difficulty. This seam is worked by the Messrs. Perry, at Briar Bluff, near Green river, in Henry county, by a tunnel driven into the hill side The coal is somewhat variable in thickness, and is sometimes cut off altogether by what the miners term a "horse-back." About forty feet below the coal the shaly limestones of the Hamilton group outcrop but a short distance to the northward of the mines. A curious phenomenon was observed at these mines in a remarkable geode like cavern or pocket, occurring partly in the coal, and extending into the fire clay beneath. The cavity was ovate in shape, and about ten feet long by five feet in width, and two or three feet in depth, and surrounded by a solid crust. The inclosed cavity was filled with water and gas, and when the pick broke through the crust an explosion followed like the firing of a blast. On breaking into the cavity it was found to be thickly set with magnificent crystals of dog-tooth calcite, from six to eighteen inches in length, the points all directed towards the center of the cavity like the crystals on the inner surface of a geode. Unfortunately many of these fine crystals were broken up and destroyed in removing them; but a few were preserved, and I was fortunate in securing some of them for the State Cabinet.

On the S W. qr. of Sec. 21, T. 17, R. 1, coal seam No 2 has been opened near the top of the bluff and immediately under the boulder clay The coal is 18 inches thick, and is overlaid by four or five feet of clay shale, forming but a poor roof. This was the first exposure of No. 2 that we met with in Henry county. The coal was underlaid by a few feet of fire clay and clay shale, and not sufficiently exposed to be accurately measured, which was followed by a bed of bluish-gray septaria two or three feet thick, exactly like that found below the Colchester coal in McDonough county. This coal appeared to be from 35 to 40 feet above No. 1 at this point.

At the Mineral creek mines I found coal No. 1 worked in a shaft sixty feet in depth, and sunk in the valley of a small creek, and about one hundred and fifty yards south east of the shaft the same coal outcrops seventy-five feet above its level in the shaft. In a boring made at this point below the coal they reported 7 feet of fire clay and 40 feet of shales, partly blue and partly gray, with a streak of coal from two to four inches thick about half way to the bottom. Some layers of sandstone, and one or more thin bands of iron ore, were passed through towards the bottom of the boring.

At the Mauch Chunck mines, about six miles west of Geneseo, coal No. 1 is worked just above the level of the creek by tunneling into the hill along its outcrop. It is here much thinner than it usually occurs in this part of the county, being reported as varying in thickness from two feet to three feet six inches. No. 2 is found here outcropping about forty feet above No. 1. A tunnel has been run into it, and considerable coal taken out, though the seam is here only from twelve to fifteen inches in thickness.

At Geneseo a coal seam crops out along the little run on the west side of the town, and is worked by Mr. Maynard in a shaft sunk from a higher level near the outcrop. The beds passed through in this shaft give the following section:

	Ft.	In.
No. 1—Soil and drift clay	20	
No. 2—Hard rock, (probably limestone)	1	3
No. 3—Sandstone	5	
No. 4—Blue shale	3	
No. 5—Coal	0	3
No. 6—Hard dark shale	6	
No 7—Hard rock (concretion ?)	0	4

Superficial Deposits.—The drift clays of Henry county run from ten to fifty or sixty feet in thickness. These are the common yellow and blue clays underlaying the soil over most of our northern prairies. No fossils of any note have been discovered in these clays, so far as I know. No beds of coarse gravel were noticed; no drift copper or galena has been picked up in the county, as in some of the counties farther north. Few boulders were observed lying over the prairies. In the valley of Green river, near its mouth, and in some of the ravines, an occasional boulder may be found washed out of the denuded soil and clay. Indeed the Edwards and Green rivers, in much of their courses, hardly show even fine pebbles along their banks.

The alluvial deposits, however, are very marked in the Green river swamp lands, and in certain curious sand ridges and hills in the north-eastern part of the county. No regular peat beds seem to exist in these swamps; but the tough sward of many grasses and sedges scarcely prevent one from sinking into the oozy muck and black vegetable mud covering these fresh-water marshes. For some cause the peat mosses have not flourished here as in the Whiteside county sloughs; but a good illustration of the origin of the prairies, according to Professor LESQUEREUX'S theory, may be seen almost anywhere along these Green river swamp lands. The sand hills of this swampy region present a more curious phenomenon still. Chains and curious-shaped round hills,

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	Ft.	In.
No. 8—Clay shale, or fire clay	1	3
No. 9—Blue shale	10	
No. 10—Black shale	0	6
No. 11—Coal	3	8

This seam has a parting of dark shale of variable thickness, and I am inclined to regard it as No. 2, which is frequently separated by a shale parting. The coal is also a rather soft and light coal, more like No. 2 than any other, though it contains more pyrite here than is usually found in it at more southern localities.

At Atkinson a coal seam about three feet in thickness has been opened on the eastern borders of the town, where it lies about fifteen feet below the surface, and from this point in a southwesterly direction it outcrops along the bluffs of Spring creek for a distance of about seven miles. Mowbray, Weatherspoon, Welch, Morrow, Shearer and Torpenning's mines are all on this outcrop. The coal averages about three feet feet in thickness, and has an excellent roof of hard, black slaty shale, passing upward into a blue clay shale containing nodules of ironstone and blue limestone. The roof shales are locally filled with *Aviculopecten rectalaterarea* and *Productus muricatus.* The nodules of limestone and clay ironstone contain *Productus Prattenianus, Pleurotomaria percarinata, P. Montfortianus, Macrocheilus,* and a minute spiral shell like *Polyphemopsis.* I have no hesitation in referring this coal to No. 3 of the Illinois river section, and it shows a regularity in the development of our workable coals along the north-western borders of the coal field that could hardly have been expected. The coal obtained from this seam has a tendency to split into thin layers, with partings of charcoal, and is a harder coal than that obtained from No. 2, and quite unlike that from either of the lower seams.

On Mud creek, a few miles further east, another coal is said to outcrop, which is probably No. 4 of the general section, and at Sheffield, Kewanee and Galva, No. 6 with its characteristic parting of clay shale, is found, thus completing the range of our most valuable coals, and showing their full development within the limits of Henry county. The general trend of their outcrop is from north-east to south-west, and the dip of the strata is to the south-eastward, but at a very slight angle. In closing these brief notes on Henry county, I desire to acknowledge my obligations to A. W. PERRY, Esq., of Geneseo, who placed himself and whatever conveyance was required at my disposal, and kindly acted as both guide and commissary during my stay in the county. A. H. W.

fashioned into shapes fantastic, and gathered and piled up by the roving winds, extend in ridges and groups from Rock river to and among the Winnebago swamps proper, in Bureau and Lee counties, and touch the north-eastern portion of Henry. In the reports upon these latter counties more will be said upon these shifting and roving hills and chains of sand.

Economical Geology.

Coal.—From the foregoing pages a good idea will be obtained of the extent, quality, and accessibility of the coal deposits in this county. The supply of this useful mineral is not likely to soon become exhausted. As opened mines are worked out, new ones will be discovered. But a small portion of the productive coal seams underlaying so large a part of the county, diagonally from its north-west to its south-east corner, has been properly or thoroughly prospected. Sources of wealth hidden away from the eyes of man are yet to be developed, and the coal of Henry county, for a long time to come, will furnish abundant supplies for home consumption, and a still more abundant supply for neighboring markets. Such minerals as coal, iron, lime, and the like, which minister so largely to the economies, utilities and conveniences of life, are not only desirable in and of themselves, but become sources of wealth and the highest material prosperity. Coal is second only to iron in every quality that can make it desirable. Especially in the prairie counties of Illinois, where fuel is scarce, coal, in even ordinary workable quantities, becomes of more than ordinary interest and value. As a steam producer for the lower Rock river valley, when all its manufacturing and milling facilities shall be developed, these coal fields bordering on the stream will obtain a new value. They will then be sought after eagerly and developed to their full extent.

Stone.—The supply of building stone, as will have already been surmised, is quite limited. The cap rock over the Cleveland coal seam will furnish plenty of stone for cellars, wells, and ordinary mason work in that part of the county. Stone of a better quality can there also be quarried from the Hamilton limestone in and near the river. The supply of limestone at Aldrich's coal mine is small, but of good quality. The sandstone outcrops below Cleveland and on Mineral creek can also be made to furnish abundance of a sandstone that will be useful for many purposes. The other outcrops and stone quarries in the county furnish only limited amounts of rather poor building stone. All the railroad towns now draw their supplies of stone from the quarries at Athens, Joliet, and other places in their vicinity, and will continue so to obtain them.

Clays.—Great abundance of the usual drift clays can everywhere be obtained. These, with proper treatment, burn into a good article of common brick.

Agriculture.—But the distinguishing characteristics of this county are its coal deposits and agricultural resources. In the latter respect Henry county ranks among the best counties in the State. Its surface is mostly a high, rolling prairie; its soil is good. The staple crops of Northern Illinois give abundant annual returns. Its population, its wealth, and its material resources are rapidly increasing. As a fruit county it also ranks among the first in this part of the State. The orchards around some of the older settled towns seem to do well; but fruit growing in the county has not received the attention its importance demands. Fruit growing and timber raising should both be looked after by the farmers of Henry county.

CHAPTER XII.

MARSHALL AND PUTNAM COUNTIES.

Marshall county is bounded on the north by Bureau and Putnam counties, on the east by La Salle and Livingston counties, on the south by Woodford and Peoria counties, and on the west by Stark county. It is twenty-four miles long from east to west, and fifteen miles broad at its broadest part from north to south, and contains, as near as I could esmate, about three hundred and fifty square miles of land. The Illinois river runs through this county from north to south, bearing towards the west. On the east side of the river are the towns of Evans, Roberts, Hopewell, Bennington, Belle Plain, Richland, and Lacon—all full towns except Evans and Lacon, which are fractional; and on the west of the river are Saratoga, La Prairie, Steuben, Whitefield, and Henry, all full towns except Henry and the next one south, which are fractional.

The only streams of importance, besides the Illinois river, are Crow creek Sandy creek, Mud creek, Spring creek, and Hickory creek. Crow creek flows across the southern tier of towns near their southern limits, east of the Illinois river. Sandy creek flows across the northern tier of towns on the same side of the river. The other three are small streams in that part of the county west of the river. The general surface of the county is similar to that of Putnam county. First, there is the Illinois river, with its broad and varying bottom; second, there are the bluff ranges on either side of the stream, with the accompanying strips of rough barren land, being the transition lands between the bluffs and upland prairies; and third, there is the level, upland prarie land, a few miles away from the bluff ranges on either side. The entire eastern end of the county, embracing almost four entire townships, is level, rather flat prairie land, with a few undulations and gentle swells. This resembles the country of the Grand Prairie in flatness and other characteristics, and is almost devoid of geological interest. The western end of the county, embracing about three townships, is also prairie, but is more rolling and dryer than that on the eastern side of river. This is the prevailing characteristic or difference between prairies east and west of the Illinois river. The former are flatter, tougher, and blacker; the latter, are more rolling, dryer, and lighter. The Illinois river bottoms, through Marshall county, partake of their usual characteristics. On the east side the bluffs, for most of the distance through the county, come close to the river. In some places, as at Lacon, a high terrace or table land runs back; and in one or two bends of the river are the usual sloughs and willow swamps. On the west side there is a broad table land or second bottom, extending from the north line of the county down to Sparland, widening out about Henry to eight or nine miles between the river and the low bluff line on the west. This tract of land is called the "Crow Meadows." It is beyond the reach of the inundations of the river, is of unsurpassed richness and fertility, although inclining slightly to a sandy plain; is thickly settled, and is under the highest state of cultivation. The flourishing town of Henry on the Illinois river, and also on the railroad between Peoria and Chicago, is built up in great part by this fine agricultural region surrounding it. The rest of the bottom, averaging a mile or two in width, is made up of the usual alluvial deposits—sand banks, mud flats, sloughs and marshes, willow thickets, meadows of coarse grass and pea vines, skirting strips of heavy timber land—the whole subject to frequent overflows, which precipitate over it a fine silt or mud, richer than the Nile ever sifted over its rich valley in Egypt.

Geology of the County.

The three divisions of the Drift deposit are easily recognized in this county. The alluvial bottoms of the Illinois river are the most recent, and have already been sufficiently referred to. They are mostly composed of fine mud and sand and various mixtures of these two substances, with occasional banks of recent river gravel. The Illinois river bottom is composed of two, and perhaps three, different kinds or ages of bottom land. First, there is the present flood plain of the stream, embracing all the low, flat lands liable to inundation by the almost annual overflowing of the river. The difference in this stream between low and extreme high water mark is some twenty-three feet, if we have been correctly informed. When extremely low, the river winds along among expanses of fine, yellowish sand, and black silt-like mud, and is a moderate sized, slow-flowing body of water. When at extreme high water mark, it spreads over a vast expanse of low land, almost washing the bluffs and terraces on either side, and becomes a broad amber-colored, muddy expanse of water. Every year this flood deposits over the flood plain mud, silt, and sand. Cultivation is making the face of the country dryer; the volume of the stream is slightly diminishing in size; the annual deposits are building up the flood plain, and altogether the valley of the river is becoming dryer, notwithstanding the constant rains the past summer have swelled it to one of its most formidable floods. Second, after leaving this low flood plain, a second bottom or river terrace may be noticed, elevated twenty or thirty feet above the flood plain. This is the ancient flood plain of the river. It is composed of loamy clay, with various quantities of sand intermixed, with occasional beds of river gravel. It produces the very best crops, is easily worked, and in an agricultural point of view is of the greatest value. Fresh water shell deposits and remains are sometimes found in it, and in similar positions in other parts of the north-west shell heaps have been found, supposed to be the remains of human feasts. It is a great deal older than the present flood plain, but geologically is comparatively recent. The Crow meadows, the Lacon prairies, and the second table on which is laid the railroad from Bureau Junction to Sparland, and a few narrow strips on the east side of the river, are about the extent of this river terrace, or ancient flood plain of the Illinois river in this county.

The two bluff ranges on either side of the Illinois river valley contain deposits properly belonging to the loess formation. They are not pure loess deposits however. Marly clays and sands intermingled with gravels are the nearest approach to the loess to be observed. These everywhere exist along the bluffs, and may be noticed in excavations and partial landslides. The eroding influences of the rains have cut them into ravines and hollows, and carried much of the bulk into the valley below. The loess mixture remains in considerable quantities however, and is well adapted to fruit culture and the growth of the vine. The foundations of the hills however, and most of their matter, is composed of Coal Measure deposits, and the older drift clays. The upland prairies are covered with the usual drift clays, of a yellowish or bluish color, similar in kind, in appearance and in depth to the drift clay deposits covering most of the prairies of the northern part of the State. Away from the river gravels few gravel deposits belonging to the older drift period exist. Boulders are not so abundant as in more northern counties. Some large ones of porphyry, syenite, and flame-colored granite, were observed on the terrace bottoms of the Illinois river.

Coal Measure Deposits.—Except the deposits of the Quaternary system above referred to, the only outcropping formation in the county belongs to the Coal Measures. Outcrops of this formation are not of frequent occurrence. In all that part of the county east of the Illinois river Coal Measure rocks scarcely outcrop at all. The prairies of eastern Marshall county, comprising much the largest portion east of the river, are level. Neither coal, coal shales or coal rocks outcrop or come near the surface. At Rutland, near the eastern line of the county, a shaft has been sunk for coal, traces of which mineral were found at a considerable depth, but no coal in workable quantities could be found, and the shaft is now abandoned. At Minonk, the next station south on the Illinois Central railroad and a few miles within Woodford county, a coal shaft has also been sunk to a depth of over four hundred feet. The company are still at work in the shaft. They have spent over twenty-five thousand dollars in the attempt to find coal at this point, as yet without substantial success. At about one hundred feet below the surface an unproductive seam of coal was discovered. Nearly a hundred feet below this another was detected, and, lower down towards the bottom, traces of a third were observed, but none of them contained sufficient coal to make their working profitable. They do indicate however the existance of coal seams under eastern Marshall county, corresponding to the La Salle and Peru seams perhaps, but probably not developed to a workable extent.

In the bluffs and ravines along the east side of the Illinois river no coal, so far as I could ascertain, outcrops, or has been worked. Stone quarries and natural outcrops of rock are also extremely rare in these bluffs and hills. In a few localities, a whitish, hard sort of limestone, which rings like an anvil when being struck with the hammer, was observed in partial outcrops. It is the same kind of rock, and belongs to the same geological horizon, as the outcrops above Trenton in Bureau county. It will thus be seen that there is nothing of special interest to the geologist in the eastern part of Marshall county. In the western part of the county the field is more inviting.

In the western bluff range, from the south line of the county to a point considerably north of its center, and in the associated ravines and hollows along this distance, sandstones, shales, black slaty clays, thin bands of limestone, and coal belonging to some three different seams, outcrop, or are mined and quarried.

At Sparland, opposite Lacon, a large number of coal mines may be examined. There are thirty or forty drifts in all, within two or three miles of the place, but most of these are now abandoned. A few are still actively worked, and furnish all the coal needed for local consumption, including that burned by several large mills and manufactories in Lacon. "Gimlet Hollow" is a crooked ravine, of a few miles in length, widening among the bluffs, having its mouth immediately west of the little village of Sparland, on the Peoria and Chicago railroad. The sides are steep and abrupt. A considerable sized brook of yellow, ocherous water flows in its bottom. Commencing almost in the village, the piles of black earth and shales, indicating the mouths of old coal drifts, may be seen on either side, and some forty feet above the level of the water in the brook. For about two miles up the hollow, these old drifts mark a regular black line along the face of the hills. Most of them are not now worked. Some have been abandoned for years. None of them have been worked with any great energy or capital; but the aggregate amount of coal taken from them in past years has been immense. The drifts extend back into the hills from fifty to two hundred yards. The style of mining has been and now is very primitive. The seam of coal is from three to four feet in thickness, and is underlaid with a coarse fire clay, and overlaid in some places with soapstone; in others with a black shale; and in others still, with a massive, dirty-white, heavy sandstone. The same seam of coal is mined at the mouth of Tinsley's Run, about a mile north of Sparland, where it presents the same characteristics, and is found to be about the same altitude on the sides of the bluffs. Following up Tinsley's Run, in its devious windings through the bluffs, outcrops of the same seam are abundant. From three to four and a half or five miles north-west of Sparland, is another group of mines, drifted into the hill sides, very similar to the group near Sparland, and all belonging to the same coal seam. From two to three miles north of Sparland, between that village and Henry, and in the face of the Illinois river bluffs, the coal has also been struck, and presents the same general appearance. Several mines are close to the railroad track in this last locality. A heavy company is running a drift into the bluffs as I write this article. The intention is to fully prove the seam, and if it will justify the outlay, to commence heavy and systematic coal mining on a scale similar to the Coal Valley Company's operations in Rock Island county. Indeed, I believe some of the Rock Island men are largely interested in the enterprise.

Below Sparland, at several places, for a distance of four or five miles, indications of the same seam exist, but as yet it has not been extensively worked in the latter localities. The fact is, this western bluff range, for a distance of six or seven miles, being between a point about three miles north of Sparland, and a point about four miles south of the same place, and extending back a few miles into the hills, is all underlaid with coal seams of more or less value.

The quantity of coal already mined, as above stated, has been great. Competition among the small miners brought down prices to the lowest living rates, and caused the abandonment of many drifts, where the show for coal was good. When capitalists and companies commence working this seam on a large scale, many valuable beds, of perhaps limited extent, will be discovered; and the mineral wealth of these Marshall county hills will add largely to the material resources of the county.

The quality of coal found in this seam is fair. The coal is somewhat soft, of a dark or shining black color. It contains a considerable quantity of iron pyrites, or "sulphur" of the miners. In a few places I noticed partial, but thin strata of this deleterious substance running through the body of the coal. When properly selected, however, this coal is considered a good steam producer, and it is largely used for that purpose.

The miners here call this the upper coal seam. About thirty feet below this upper seam, and a number of feet above the level of the water courses, is another seam, which appears to be nearly as thick. In several places up Gimblet Hollow, we noticed the natural outcrops of this seam, about thirty or thirty-five feet below the mouths of the drifts in the other one. The seam, where examined, was about three feet thick. The coal was soft, with a reddish-brown tinge of color; but the coal examined was at the immediate outcrops. Drifts carried into the hill, would, I think, disclose coal of a better quality, and of workable thickness. At no place, however, could I find that this seam had been extensively worked, or even fairly tested, and I am of opinion that in some of the hills immediately west of Sparland, there is a considerable body of good coal in this seam. It exists also up Tinsley's Run, and in every locality I believe where the other is worked. Towards the top of the seam I noticed everywhere two thin, whitish-colored clay partings, each about an inch and a half thick, near each other. The upper one is from six to eight inches from the top of the coal; the other, about three inches below the upper one. Partial strata of iron pyrites also are found in connection with the clay partings. At a point below Sparland, called Minersville by the coal-workers, some attempt has been made to develop this seam and fully test its value; but the attempt has been mostly abandoned, and the experiment, up to the present time, has not proved successful. These clay partings would seem to indicate that this is the Wataga seam of coal, mined so successfully in Knox county, west of this locality, being identical with the Middle Peru and LaSalle seam, or Number 5 of the amended coal section of the Illinois river. If so, and I think there can be no doubt of this, the upper seam, above referred to, doubtless, corresponds with the Upper Peru and LaSalle seam, or Number 6, of the same section.

At Minersville, traces of a still lower seam have been discovered at a considerable depth below the latter. This is probably coal seam Number 2; but there is no evidence yet of its development to any large extent in this county. The attempt to make it of economical value will not be seriously undertaken.

What the coal interests of Marshall county need, is a more extended and scientific working of her upper coal seam, and a thorough examination and proving of the lower one.

Leaving the coal seams and coming to the associate rocks and deposits, we find nothing worthy of special attention. Both seams of coal have under them, at most places examined, a bed of the usual coarse fire clay. The roof of the upper seam is composed of the usual dark-colored shales, clay shales, and soapstone. The latter was noticed only at certain localities, was of a clay color, greasy feel, and rather massive in appearance. Between the two seams of coal outcropping about Sparland and northwest of that place, is a massive, light-colored, coarse, gritty, and very soft sandstone, about thirteen feet thick. On being quarried and dried, it seasons and becomes sufficiently hard for economical purposes. A similar bed of sandstone outcrops higher up on the hill sides, especially at some points on Tinsley's Hollow. This is above the upper coal, and, in some instances, it almost forms the roof of that seam. Higher still, and almost crowning these Sparland bluffs, a thin outcrop of a white, hard limestone seems to lie immediately below the small amount of loess and drift clays and gravels, making the bald tops of the hills. It is only three or four feet in thickness, but affords a good quarry rock, and is used in a few places for burning into lime, of which more will be said by and by.

The following section gives approximately the Coal Measure deposits of Marshall county. The measurements were not accurately taken, and all the strata mentioned will not be found at any particular locality. The section is a general average of these Sparland Coal Measure outcrops and bluffs.

Section of Sparland Bluffs.

*No. 1.	Loess and drift-clay capping the bluff, not measured.		
No 2.	Thin band of whitish limestone.	4	feet.
No. 3.	Clay shale—exposures partial—about	50	"
No. 4.	Shale and sandstone.	13	"
No. 5.	Coal. (No. 7 ?)	3½	"
No. 6.	Fire clay, shales, etc , about	11	"
No. 7.	Light-colored, coarse-grained sandstone	14	"
No. 8.	Clay shales	5	"
No. 9.	Coal, with clay partings, (No. 6 ?)	3	"
No. 10.	Fire clay and shales, about	20	"

All the coal-bearing hills west and north-west of Sparland are of exactly similar formation, and would present similar sections. On leaving the river hills and ascending to the high upland prairies, all evidences of these sections disappear, but a deep shaft in most parts of the county over the upland prairies, would disclose traces of many of the strata in in the above section, and in some places might develop coal seams of workable thickness.

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*NOTE.—From our examinations in the vicinity of Chillicothe, in Peoria county, and extending northward to the south line of Marshall county, we have no doubt but the coal seams represented in the above section are Nos. 6 and 7 of our general section of the coal seams in the Illinois Valley. A. H.W.

Economical Geology.

Coal.— Under this head I can add very little to what has already been said about the coal of Marshall county. The seam already worked has produced a large amount of coal, chiefly mined for local purposes; but no statistics were gathered as to the amount of coal already mined. But from the number of banks which have been opened and worked, and the extent to which some of the drifts have been carried, and the number of years the banks have been known, there can be no doubt that the coals of Marshall county have added largely to her material resources. Sparland is almost a mining village, and other localities support many families engaged in mining coal. All this mining, however, has been carried on in primitive style. Few heavy capitalists, and no heavy companies have engaged systematically and scientifically in the development of these coal seams. Nearly all the mining done has been in the upper seam; and that, I think, has not been exhausted, except at certain spots. The miners believe, and experience will prove, that many local deposits belonging to this seam are richly worth the working. The seam outcropping immediately below this appears to be thick enough to justify the belief that it, too, will afford a fair supply of the useful mineral. It is high enough to be easily drained, and in other parts of the coal field not remote it has proved a valuable seam.

Nothing, however, but the actual test of proving these seams at any locality desired can be depended on in making an estimate of the amount and quality of coal in them. They thin out and disappear in some localities, and the productive coal beds in even the best portions of Northern Illinois are somewhat local in their character, so that an examination of the exposures to be met with in this part of the State cannot be depended on in predicting results. A few hundred yards, or a few hundred rods drifting in any direction in our heaviest coal seams, may come to the productive limits of a local coal field in which parties may be at work. Shafts over some of the prairie portion of the State may disclose only traces of the coal seams outcropping in considerable thickness near the Illinois river, just as the shafts at Rutland and Minonk, in and near the eastern limits of the county, have disclosed traces of unproductive coal seams; but it by no means necessarily follows that these unproductive measures extend over any considerable area of the Illinois coal field.

Building Stone.—A limited supply of rather poor building stone may be obtained along the western bluff range of the Illinois river for a few miles above and below Sparland, and in and about all the outcrops of the coal seams. The heavy, soft sandstone about Sparland is quarried in considerable quantities for foundations and ordinary farm and cellar masonry. On first being quarried it is too soft and crumbling; but exposure to the weather seasons it and adapts it to the above purposes. It is not a good building stone, but for want of a better is used to some extent. It is very coarse-grained and gritty.

The thin band of outcropping limestone above referred to furnishes a hard, compact building stone, rather unshapely and hard to work as it comes from the quarry. The quality is good and the color is warm and rich; but the trouble of working it into shape will always prevent its use, except for rough masonry. Good stone can be obtained so easily from La Salle and Joliet, that it will not pay to quarry these limestones extensively for building purposes.

Over the upland prairies, and even along the eastern bluff range, stone quarries and outcrops of stone are hardly to be met with. The farm houses and barns are built upon blocks, bricks, and all sorts of foundation materials, except good foundation stones. In riding through a country, and observing the foundations of the houses and barns, an unfailing indication may be had as to the condition of the country with reference to the outcrop of rocky geological formations. Applying this test to eastern and western Marshall county, we shall not be disappointed. A few of the hills show a gravelly appearance, or limited outcrops of a hard, ringing, light colored rock, and that is about the extent of the outcrops which present themselves for examination.

Lime.—A few lime kilns now are or have been in operation in the county. One of these, about one mile above Sparland, on the point of a bluff, makes a considerable quantity of very good lime. The material used is the light colored, hard limestone from the thin outcrop near the top of the bluff. The lime is very white and rather fine-grained. It is used in the neighborhood quite extensively, but will never, perhaps, become an article of shipment to other counties. All points accessible to railroad depots can be supplied with good lime from other localities so easily and cheaply that these lime kilns will never obtain anything but a local trade.

Sands and Clays.—All along the Illinois river plenty of good river sand may be obtained fit for various economical purposes. It lies in banks and drift beds, and ranges from a fine washed to a coarse gritty grain, according to the conditions of the waters which assorted, arranged and deposited it. Its color also varies. In some places it is almost as white as St. Peter's sandstone. In others it is of a yellowish and brownish hue.

The clays of the Illinois river bottom are especially suitable for the manufacture of common red brick. They are partially mixed with sand, and burn into a very solid, ringing brick, well adapted for ordinary building purposes.

General Remarks.—Very few fossils were found in this county. In the ravines about Sparland specimens of *Lepidodendron* are sometimes picked up; and I was informed that the associate shales of the coal drifts often contained rather poor specimens of fern leaves. The shales observed by me were too much decayed to afford any thing but traces of these ferns, and a few stems of some kind of coal plants. The sandstones and limestones examined seemed almost unfossiliferous. More extensive working of the beds might develop fossiliferous strata.

It will thus be seen that the general geology of the county is comparatively devoid of interest. The Sparland coal banks will always excite more or less attention, and will remain sources of a considerable supply of coal. It will mostly remain a local trade in coal, however, unless some heavy company is fortunate in finding a good mine near the railroad.*

PUTNAM COUNTY lies on both sides of the Illinois river, a short distance below its great bend at La Salle. It is bounded on the north by Bureau and La Salle counties; on the east, by La Salle county; on the south, by Marshall county, and on the west by Marshall and Bureau counties. It is one of the smallest counties in the State, and contains four irregularly shaped towns, three of which are east of the Illinois river, and one west of it. These towns are Granville, Hennepin and Magnolia, on the east, and Snatchwine, on the west side of the river. The county contains in all about two hundred and sixty-six square miles,

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*NOTE.—Since the foregoing report was written a boring was made at Sparland to the depth of 182 feet below the lower seam outcropping in the river bluffs. For the following section of this boring I am indebted to Mr. CHAS. SARGENT, of Sparland:

Section of Boring.

	Ft.	In.
No. 1—Surface clay	10	
No. 2—Sandstone	2	
No. 3—Shale	40	
No. 4—Black slate or shale	3	
No. 5—Coal (No. 4?)	0	6
No. 6—Shale	10	
No. 7—Quartz (Sandstone ?)	0	6
No. 8—Sandy shale	91	
No. 9—Black slate or shale	2	
No. 10—Shale	6	
No. 11—Coal (No. 3?)	2	8
No. 12—Fire clay	2	6
	170	2

It is probable that the coal found here at the depth of 165 feet is No. 3 of our general section of the Illinois valley coals, though it may be No. 2, as the character of the roof, as reported in the boring, would seem to indicate. It is to be regretted that this boring had not been continued to the bottom of the Coal Measures, which could have been reached in about 120 to 150 feet from where the work terminated. as it is quite possible that coal No. 1 might have been found here as thick, or even thicker, than the one penetrated. This would have settled the question as to the probable amount of coal underlaying this portion of the county. A. H. W.

and is, at the longest measurement, about fifteen miles long from north to south, and about twenty-five miles from east to west.

Surface Configuration.—The most marked feature in the surface configuration of the county is the Illinois river and its attendant bluffs and bottoms. The river itself flows along the northern boundary line of the county from the north-east to the north-west corner of the county, at which latter locality it makes its great bend from a western to a southern course. It flows along the western boundary line until it reaches the township of Snatchwine, which township it leaves on the west. The river bottom, within the boundaries of this county, is not so extensive as in other counties in this part of the State. On the eastern side the bluff range keeps near the river through the entire extent of the county. About Hennepin, and immediately below, it is a sort of high prairie, rising gradually back from the river. This is a sort of medium table land between the alluvial bottom and the highlands back from the bluff range. It is very fertile, but rather sandy, and is under a high state of cultivation. On the west side of the river, from its entrance into the county to the south line of the same, the river bottom is from one-half to about two miles in width, except at the southern boundary line, where it widens out into the upper extremity of the "Crow Meadows," in Marshall county. This stretch of alluvial bottom land is subject to almost annual inundations from the overflow of the Illinois river. It is one interminable wilderness swamp, penetrated with sloughs and swales, overgrown in places with thickets of water-willow, dense with heavy grasses thickly interwoven with pea vines, receiving from each overflow a deposit of soft mud silt, with one or two slough-like expanses or lakes during low water; a broad expanse of yellow, thick, cream-colored water at high flood of the river; a pestilent tract, breeding fevers, frogs and mosquitos; skirted in two or three places with bottoms high and dry enough for cultivation. Such is the character of this bottom. In it there is some heavy timber skirting the river. Banks of sand and fields of mud and silt alternate along the stream.

The bluff ranges on both sides of the river have nothing peculiar about them. They rise to an altitude of from 80 to about 125 feet. For the most part they are gently rounded and covered with a light growth of scattering timber. They are composed for the most part of drift clays, and gravels, and Coal Measure deposits, occasionally showing loess, marly clays, and sands. From the brow of these bluffs, in either direction from the river, is a tract of rough or barren land from one to about four miles in width. These strips of land are somewhat rough; are intersected by numerous ravines, and are more or less covered with a scattered growth of oak timber. These rough lands, although not so well adapted to agriculture as the more level portions of the State, will produce fruits in perfection, and the cereals grown upon them have a plumper berry and more weight than those grown upon the flat prairies.

Leaving these intermediate tracts of rough barrens, the rest of the county, both on its eastern and western sides, settles off into the usual level Illinois prairie land. On the east this strip of prairie is from six to twelve miles wide. It is generally quite flat, with a few gently swelling elevations. It is almost devoid of timber, of stone, of coal, and of large streams of water. The soil is black and fat, but in wet seasons much of it is a little too flat. Along the western part of the county the prairie is more rolling, dryer, and with a lighter, warmer soil.

Streams.—Except the Illinois river, there are no streams of any size in the county. "All Forks" is a considerable sized brook; the rest of the county, and especially the more level prairies, have many small brooks and rivulets, for the most part without steep banks or hills. They are essentially surface streams. dry in dry seasons, and draining off the surface water in wet ones.

Geology.

Quaternary System.—There is nothing of special interest in the geology of this county. Outcrops are few and far between. The variety of formations is very limited. The surface geology is made up of the usual Quaternary deposits. The soil and sub soil of the prairies, the few narrow creek bottoms, and the usual Illinois river bottom, are well-marked alluvial deposits. Of these nothing need be said, except almost to reiterate the statements about the same deposits of Marshall county. Along the Illinois river there is the same low bottom, slightly contracted in width. The present flood plain of the river is composed of the same fine, black, soft-grained mud and silt, very fat and productive when dry enough for cultivation; the same banks and beds of variously colored sand of different degrees of fineness, according to the conditions of the waters which assorted, arranged, and deposited it; the same system of sloughs, willow growths, and meadows of rushes, and water grasses; and the same oozy pools of green scum, pestilent-breeding beds of agues and intermittent fevers.

Along the Hennepin prairie, and in a few other localities, there are considerable strips and stretches of river terrace land, the ancient flood plain of the river, when its waters ran many feet higher than they do now. Some very fine farms, in the vicinity of Hennepin, are made upon this older alluvial deposit. Few traces of the loess clays and marls were noticed, but the river bluffs are undoubtedly crowned with a clayey deposit, more or less partaking of the nature of this formation. The more level portions of the county are covered with the usual drift-clays, about which nothing need be said. They have been sufficiently described in the published works of the survey, and in many of the detailed county reports. In this county they are similar, both in quality and thickness, to like deposits in neighboring prairie counties. They belong to the older Quaternary, or true drift deposits. Over the prairies, and especially about some of the little surface streams, an occasional black or flesh-colored boulder can be seen, "lost rocks," indeed, in an ocean of prairie clays. Along the shores of the Illinois river, and on a line between the present and ancient flood plains of the stream, a few very large masses of transported rock lie half buried by the debris of ages. One of these masses, near the Putnam and Marshall county lines, would weigh many tons. It is a pale flame-colored granite. Similar masses lie in the waters of the river at several places. In one or two instances, I noticed great rocks of this kind, partially buried by a soft silt-like mud. I did not notice in this county any beds of coarse, transported gravel. On the face of some of the bluffs, and in some of the ravines, there is a rather coarse gravel, but it seems to be composed of water-worn fragments of Carboniferous rocks, similar to the natural bed rock of the county. The ice and water forces, acting in ages past, in and along the Illinois River Valley, doubtless smoothed the original rocky projections of the beds, and these are the water-worn fragments of the rocks, abraded, and carried away to short distances only from their original Carboniferous ledges.

Geological Formations.—If the Quaternary deposits be stripped from the bed rocks all over the county, the surface would then present, in all probability, only Coal Measure rocks and associate deposits, representing, perhaps, the same strata that are far better exposed in Marshall and LaSalle counties.

Commencing at the north-east corner of the county, we may reasonably infer that Coal Measure deposits, similar to those existing about LaSalle and Peru, underlie the surface. From this point, it is but five or six miles to the extensive coal shafts at and near Oglesby, just south of the Illinois Central railroad bridge across the Illinois river. The bluff range, on which the south end of the bridge abuts, continues on down the river south west into and through Putnam county, without any material change in appearance. The Peru coal shafts are even nearer to this corner of the county, but are on the other side of the Illinois river. All the north part of the county east of the Illinois river contains beneath it these same Coal Measure deposits, subject only to local changes; but the coal seams themselves may have thinned out, as no valuable deposits of coal have as yet been discovered. The Peru and LaSalle coal seams, as they extend south, on the eastern side of the Illinois river, dip to the southward, and as the superincumbent drift materials increase to nearly a hundred feet in thickness over the Coal Measures, the coal seams are nowhere exposed above the surface. All the south-eastern part of the county is underlaid by these same formations, except that they have more and more lost surface indications of the coal seams. Natural outcrops do not exist, and no borings have been made so far as I know, and, of course, our knowledge of things hidden beneath the surface cannot be very definite.

Following the trend of the bluffs from the above starting point to the south line of the county, nothing very definite shows itself. Traces of sandstone along their bases, and of limestone higher up, may sometimes be noticed. The former is the coarse, massive, friable sandstone, and the latter the light-colored limestone, described in the reports upon the the geology of Marshall and Bureau counties. The country being rough, and timbered for most of the distance, except the Hennepin prairie, stone is not quarried, and the opportunities to examine outcrops are very scarce. Indeed, I hardly know of a good outcrop in the county, either natural or made by quarrying, and there certainly is no outcrop where a fair section can be made.

These remarks apply more particularly to the large fractional township of Hennepin, laying immediately adjacent to the Illinois river on the east. The two eastern townships of Magnolia and Granville are dead-level prairie land, devoid of outcropping strata of any kind, except towards the river on the north.

West of the Illinois river, the single large township of Snatchwine, which is the only part of the county west of the stream, the geology is similar to that of south-eastern Bureau county, except that no productive coal seams have been discovered. There is also a slight sinking or dip of the strata towards the south. At the north line of the county the bluffs are not remote from the river, and the valley on that side is narrower than in some other places. The trend of the bluffs bear gradually away from the river, at the southern limits of this large township, and the northern extremity of the "Crow Meadows" is reached. The bluffs show some unworked outcrops of the hard, semi-crystaline limestone, noticed about Trenton, in Bureau county, but they are not quarried, and show no fossils where examined. The western end of the township is prairie, without anything of geological interest.

This is about all that can be said about the geological structure of of this little county. On the map it should be marked as underlaid by the Coal Measures, except the valley of the Illinois river, which should indicate alluvial deposits. The county is quite small, and its geology is uninteresting. Its detailed report will consequently be short and somewhat unsatisfactory. Such counties as LaSalle, and others in that part of the State, afford the geologist a more interesting field for observation.*

Economical Geology.—Although underlaid by the Coal Measures, coal in workable quantities has not yet been discovered in the county. In the north western and south-western portions, coal seams may exist, but their character and extent remain to be proved, but it is likely that valuable beds will yet be discovered. The same might also be said of stone suitable for the purposes of building or other economical uses. The stone quarries, if any good ones exist, lie concealed beneath the surface, and have not yet been opened. Lime, as a natural consequence, is not burned to an extent that would make it a valuable production. The railroad and river facilities for transportation will always enable the citizens of this county to obtain coal, stone, and lime from other places with very great ease. Sands and ordinary clays exist in great abundance. Materials for the manufacture of common red brick can be found in most parts of the county, and in the valley of the Illinois river these materials are of excellent quality. For agricultural purposes, fruit-raising, and wine-growing, this county is very similar to Marshall county.

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* NOTE.—The hard, blue limestone which forms the upper bed of the Coal Measures at Sparland, I have no doubt is the same bed outcropping at Jones' Prairie, and at Lonsdale's Quarries, in Peoria county, and usually lies about fifty feet above coal No. 7, and from ninety to one hundred feet above coal No. 6, and one hundred and fifty feet above coal No. 4. As this limestone is mentioned by Mr. SHAW as outcropping in the bluffs of the Illinois, in this county, it may serve as a guide to those in search of coal; and it will indicate the depth to which it would be necessary to go in the vicinity of its outcrop, to reach either or all of the above named coals. It is probably the same as the limestone No. 32, in the general section of the Coal Measures of LaSalle county, given on page 265, in Vol. III of these reports. A. H. W.

CHAPTER XIII.

ROCK ISLAND COUNTY.

That part of Rock Island county north of Rock river is bounded on the south by Rock river, on the west by the Mississippi river, and on the north and east by the Marais d'Ogee slough, and a portion of Whiteside county. It is an irregularly shaped, triangular piece of land, some twenty-eight and one-half miles long on its western boundary, about seventeen miles wide across the north end, and gradually tapers to a point at the junction of the two rivers a short distance below Rock Island city.

Its physical features, and surface configuration, are a good deal diversified. Broad sand prairies, low alluvial bottom lands, abrupt bluffy highlands, and various combinations of these, make up the general face of the country. At Cordova the bluffs rise abruptly from the sandy plain. They follow the trend of the Mississippi river close along its shore, and are abrupt, broken, and rough. About Moline and Rock Island they recede a mile or two from the river but strike Rock river at Camden. Up this latter stream they continue for a few miles, rising high and abrupt from the water's edge. Soon they commence drawing away from this latter river, leaving a low alluvial bottom. They then trend off to the north, leaving the same low bottom between themselves and the Maredosia slough, along the Whiteside county line. Following this course five or six miles, they suddenly bend to the west, and strike the Mississippi near Cordova, the place of beginning. This part of the county has in it six named townships, not bounded by regular township lines, but made up mostly of irregularly-shaped fractional government townships. These contain somewhere near one hundred and seventy-eight square miles or sections of land.

All that portion of the county within the above bluff line boundary, is highlands or uplands, from fifty to one hundred feet above the general water level of the Mississippi river. It is abrupt, broken, rolling, and rough. Much of it, especially the hills and ravines, is covered with a scattering growth of timber and brush. Pleasant Valley, cutting across this upland region from Hampton on the Mississippi to Carbon Cliff on

Rock river, is the only considerable depression in this elevated plateau. This valley, though small, contains some good farm lands. Over this elevated region, especially towards the north east, many small farms are opened. The soil is thin, but well adapted to the growth of cereals and fruits. The alluvial bottoms, when dry enough to cultivate, make the best and richest corn lands, and the wet portions make good meadow and grass lands. The agricultural resources of northern Rock Island county are not very rich or varied. Much of the land is unproductive, much of it is too high, or too low, or two sandy, small portions of it are almost unsurpassed for fertility.

As a fruit growing region it ought to excel. Some of the large apple orchards along the bluffs near Cordova, bear abundantly and uniformly, and produce fruit of excellent quality. That whole encircling range of bluffs have hundreds of localities where the hardier varieties of the vine might be raised with great success. There is no reason why grape growing and wine making might not be made a producing interest of the county. The few local experiments with the vine, tried by amateurs, certainly give promise of this.

The manufacturing facilities of Rock Island county are among the best in the State. The coal is abundant and cheap, the water powers are heavy and conveniently located. The well-known power at Moline, obtained from an arm of the Mississippi river, has built up a flourishing and wealthy village within sound of its roaring wheels, and sends out its shining steel plows and other manufactured articles over the northwest.

At Camden a vast enterprise has been undertaken. When I was last there (in 1868) Rock river was turned out of its accustomed channel by a series of coffer and other dams, and a little regiment of men and teams were at work in its bed, quarrying rock and building one of the most elegant and solid dams on the whole river. Foundations for mills and other buildings were also being laid. The object is to build up another manufacturing village at this locality, that shall rival or surpass Moline in wealth and importance. The natural advantages are abundant, men of energy and abundant capital are at the head of the enterprise, and there is no reason to anticipate a failure.

Surface Geology.

The Rock river and Maredosia bottoms, above referred to, belong of course to the alluvial deposit. They are from two to five miles wide. Their character and agricultural capabilities have already been stated. That part of the county north of the bluff line, made up mostly of the township of Cordova, is a broad, level sand prairie, and at a time when the Mississippi river flowed a mightier stream, both in its present channel and in the Maredosia slough, it was a broad headland sand-bar. The bluff bounded highlands above described then rose as an island from the broad lake-like river. The drifting sands lodged against its upper end, and the sand-plain under consideration was gradually formed, just as sand-bars of the present day are formed against the upper end of river islands.

This sand deposit took place during the long ages, while the Mississippi valley was occupied by a mightier stream than the present river, and a part of its waters found a channel through the Maredosia bottom, and the present valley of Rock river below its outlet. I have discussed at length, in the geology of Whiteside county, the proposition that the Mississippi once flowed through this latter bottom, and into Rock river at Erie, and need not now make farther remarks upon that subject.

The narrow bottom from Hampton to Camden is an ancient shore or beach. It is dry, and in some places rocky. But the most curious phenomenon along the Mississippi bluffs is the old shore-line marked along their sides. At Cordova, the principal part of the town is built upon this ancient beach or terrace. It is here some fifty feet above the present low water mark of the Mississippi river. It is distinctly marked all along the bluffs to Camden, but runs lower as it passes from Cordova to the latter place.

The bluffs and hills of Rock Island county are composed in part of the whitish buff clays, sands, and marly deposits known as the loess. Receding back from the bluff lines the loess thins out, and is succeeded by fine laminated drift clays, such as cover most of our upland barrens and high prairies. Large boulders are of rare occurrence; so are genuine drift gravel beds. Beds of recent river gravel mark the present shore lines of the streams, but these are of very recent formation.

Coal Measures.

In that portion of the county lying west of Rock river, the Coal Measures are found as outliers, overlaying and resting unconformably upon the Devonian and upper Silurian limestone, as far north as the vicinity of Port Byron, where they finally terminate. The most northerly point where a workable bed of coal has been found on this side of the river is at Rapids City, where the seam, probably the same as that two miles east of Hampton, and at Carbon Cliff, is said to be from four to five feet thick, and overlies the Niagara limestone, with only a few feet in thickness of shales and fire-clay between.

Two miles east of Hampton, several shafts have been recently sunk on a good seam of coal from four to five feet thick. The coal and the associated strata are the same as at Carbon Cliff. The coal here has a tendency to the block character, breaking easily into quadrangular pieces.

It is overlaid by bituminous shales, and argillaceous and silicious limestone, which is capped with a band of chert from four inches to a foot in thickness, above which we find silicious shales and sandstone. The dip of the coal is very irregular here, sometimes rising nearly to the surface level and then sinking to the depth of sixty to seventy feet; probably conforming to the irregular surface of the underlaying limestones. The coal at this point appears to occupy a limited basin, that has been proved by borings to extend for about three quarters of a mile in one direction, by about half a mile in the other, covering a portion of sections 15, 16 and 22, in town 18 north, range 1 east. The Hampton shaft, Ætna Coal Co., Durfee shaft and Davenport & Co.'s shaft are all on this little basin.

The Carbon Cliff mines were located on Sec. 4, T. 17 N., R. 1 E., and were among the earliest mines worked on the west side of Rock river. For many years extensive coal operations, in connection with an establishment for the manufacture of pottery and fire brick, were carried on at this point under the management of W. S. Thomas, Esq., but the limited supply of coal finally became so nearly exhausted that mining was no longer a profitable investment, and the mines have been abandoned. A section of the Coal Measures at this point, the upper part obtained by surface exposures, and the lower part furnished from the records of a boring made by Mr. Thomas, will give a general idea of the measures as they are developed in this part of the county:

	Feet.
No. 1—Streak of bituminous shale, probably indicating the horizon of coal No. 2	1
No. 2—Silicious shale and sandstone	18
No. 3—Blue argillaceous shale and limestone, with a band of chert	15
No. 4—Bituminous shale	1
No. 5—Coal	3 to 4
No. 6—Fire clay	2 to 3
No. 7—Sandstone, dark blue clay shales, with bands of iron ore, and thin coal, or bituminous shales, passed through in the boring	70
No. 8—Gray Devonian and upper Silurian limestones penetrated to the depth of two or three hundred feet.	

The band of chert in the shales over this coal forms a reliable guide to the identification of the strata both in this county and in Henry. It varies in thickness from four inches to two feet, and in color from a light gray to black. It has the conchoidal fracture of a true flint, and was used by the Indians for the manufacture of their implements of war and of the chase. The limestone over the coal contains but few fossils at this locality, but the *Spirifer cameratus* and *Athyris subtilita* seemed to be the most common, and *Productus longispinus*, *P. Prattenianus* *Chonetes mesoloba*,and a minute *Trematopora* were also observed, but more rarely.

An analysis of this coal, by Mr. HENRY PRATTEN, former chemist of the survey, gave the following results:

Moisture	7 0
Volatile matter	36 7
Carbon in coke	52 8
Ash (white)	3 5
	100 0
Carbon in coke	55.3

In the vicinity of Camden, on the western shore of Rock river, the lower beds between the Devonian limestone and the Carbon Cliff coal are well exposed, showing an outcrop of a thin seam of coal just above the river level. Above this thin seam there is a bed of coarse sandstone that sometimes passes into a sandy shale, above which is another coal seam two feet in thickness. The exposure here gives the following section:

	Feet.
No. 1—Sandy shale	30 to 35
No. 2—Bituminous shale	4
No. 3—Coal	2
No. 4—Fire clay	1 to 2
No. 5—Sandstone and sandy shale	20 to 25
No. 6—Thin coal	1 to 2
No. 7—Shale	1 to 3
No. 8—Devonian limestone.	

It is possible the upper seam in the foregoing section may be the equivalent of the Carbon Cliff coal, but I am inclined to regard both these thin seams as intercalated beds underlaying the main coal of this county. The seam at Carbon Cliff and Coal Valley I consider as identical with the Seaville coal in Fulton county, and as No. 1 of the Illinois river section, published on pages 5 and 6 of the third volume of these Reports. If this conclusion is correct, then the two thin coals in the above section are the representatives of the sub-conglomerate coal of Southern Illinois. The fact that they have nowhere been found in this portion of the State thick enough to be of any economical value, except for local use, seems to favor this conclusion. The seam of so-called cannel coal opened at the foot of the bluff near Colona, in Henry county, and similar beds of highly bituminized shales that occur at some other points in Rock Island county, may probably be referred to the same horizon. In the bituminous shale overlaying the two-foot coal seam in the above section, we obtained a few plants, among which the *Lepidodendron clypeatum* was the most abundant.

The Hamilton Limestone.

About a mile and a half below Hampton the upper and more shaly beds of the Hamilton limestone first begin to outcrop along the Mississippi river. About Moline still heavier outcrops exist. These are thicker-bedded, are of a brownish color, and are full of fossils. At Rock Island City, and about Camden, it becomes more massive; the stratification is irregular; the color a bluish-white or brown upon recent fractures, and the stone hard and tenacious. At Camden the bed of the river is a solid floor of these irregularly-shaped rocks. They are worn smooth by the flow of the heavy, swift-running waters, rushing over them for ages, and stained a mud color by the sediment. It underlies all that narrow bottom reaching from Moline to Camden, and attains a thickness in its outcrops of perhaps thirty feet. Rock Island, in the Mississippi river, is a vast pile of this Hamilton limestone, rising in the midst of the stream, overlaid by a thin soil, and covered by a magnificent young forest.

The Devonian limestones, as they are developed in this county, may be readily separated on lithological grounds into three divisions. The uppermost division consists of gray and brown limestones, the lower layers rather coarse-grained and completely filled with the shells and corals peculiar to the Hamilton beds. This may be estimated at from twenty-five to thirty feet in thickness, and is well exposed near Andalusia, and on the opposite side of the river near New Buffalo. The middle division consists of brown argillaceous limestones and calcareous shales, full of the characteristic shells of this group, and from 30 to 40 feet in thickness. This division is well seen between Rock Island and Moline, where a perpendicular face of thirty feet or more in thickness is exposed in the quarries. These shaly limestones are underlaid by a fine-grained, gray or dove-colored, compact limestone, the upper part tolerably massive, but becoming thinner-bedded below. It extends below the river level, and is said to have been penetrated in some borings made here, several years since, to the depth of more than a hundred feet. This would make the aggregate thickness of the Devonian limestones at this point from one hundred and fifty to one hundred and seventy-five feet.

Fossils are quite rare in the lower division of this formation, but we found in its upper beds *Atrypa reticularis*, *Alveolites Goldfussii*, and a *Phillipsastrea* of the same species as that common in the upper division. The shaly limestones of the middle division contain *Spirifer pennatus*, *S. Parryanus*, *S. aspera*, *S. bimesialis*, *S. subattenuatus*, *S. inutilis*, *S. fimbriatus*, *Cyrtia umbonata*, *Productus subalatus*, *Strophomena demissa*, *S. fragilis*, *S. lepida*, *Orthis Iowensis*, *O. suborbicularis*, *O. Vanuxemi*, *Megistocrinus latus*, *Synbathocrinus matutinus*, *Taxocrinus interscapularis*, *T. gracilis*, *Pentremites sub-truncatus*, *Platyceras ventricosum*, *Astreospongia Hamiltonensis*, *Fenestella bifurcata Polypora Hamiltonensis*, *and Striatopora Iowensis*. There are also to be obtained from this division several species of turbinated corals, and a *Gomphoceras* that have not as yet been specifically determined.

The upper division contains many of the species above named, and in addition many corals belonging to the genera *Phillipsastrea* and *Stromatopora*, associated with *Cystiphyllum Americanum* in great numbers. There are also some brown beds near Andalusia that contain numerous *Gasteropods and Orthoceratites*, and a few miles below, these are overlaid by from eight to ten feet of a brown magnesian limestone that contains casts of a large *Spirifer* like *S. Parryanus* and *Strophomena demissa*. These brown beds are directly overlaid near the mouth of Stonecoal creek by the sandstones and shales of the Coal Measures. There can be no doubt that the two upper divisions of this limestone fairly represent the organic forms of the Hamilton group as it appears in New York and Canada, and as no fossils specially different from these have been obtained from the lower bed, we see no good reason for assigning that division to a lower formation. This group attains a greater thickness here than at any other point in the State, and at the first outcrop of this limestone to the southward, in Calhoun county, its entire thickness scarcely exceeds ten feet.

Niagara Limestone.—From Cordova to Port Byron this formation outcrops heavily. Leaving Port Byron it gradually sinks as we approach Hampton, and a little south of that place disappears beneath the outliers of the Coal Measures. The stone at Cordova has a tough, hornstone like consistency and appearance, unlike its outcrop at Fulton and farther north. Some of its top layers break with a splintery fracture, and the lines of stratification and bedding are very irregular. It has some of these characteristics at Port Byron, but is more brecciated in structure and yellow in color. Stems of encrinites, some of them half an inch in diameter, fill some of the large blocks of limestone at this point Following the bluffs from Cordova eastward and down to Pleasant Valley, this limestone outcrops and is quarried in many places, both in the face of the bluffs, and by digging into the higher bottom land between the bluffs and the Maredosia slough. Its characteristics along this eastern exposure of outcrop change a little. Minute dendritic spots or stars give a speckled appearance on fresh fractures, and the color is a yellow or reddish brown. The stone is softer, and occasional fragments of *Pentamerus oblongus* are seen. All that upland region north of Pleasant Valley is underlaid by this Niagara formation and a thin outlier of Coal Measures, but the soils and upland clays deeply cover them, except where the small streams cut down through the superficial deposits.

Economical Geology.

The horny, tough, splintery layers of the Niagara limestone burn into an excellent quick lime. It is white, strong, and pure. At Cordova and Port Byron fires almost perpetually glow in extensive lime kilns, and the lime made at these localities has a wide reputation and commands a ready sale, and an extensive business in this line is done here. The Hamilton limestone of Rock Island is a very pure carbonate of lime, and is manufactured into a good article of quck lime. It is extensively used in the government works and buildings, now in process of erection on the Island, and although coarse, it is strong and makes a firm cement for heavy masonry.

Lime enters extensively into all the arts, uses, and utilities of life. Like iron, coal, clay, sand, and many other familiar materials of daily use, we seldom stop to consider its many uses in the economies and conveniences of life, and the localities offering facilities where it can be manufactured cheaply and of superior quality, have elements of material wealth worthy the attention of capitalists and political economists. Such localities exist at Cordova, Port Byron, Albany, Rock Island, and other places along the Mississippi in this part of the county. Transportation by rail and water is easy, coal and wood are abundant and accessible for fuel, the Niagara cliffs and Devonian beds furnish abundance of the raw limestones, and no better place can be found for making the manufacture of lime a good paying business.

The coal seams north of Rock river, as before stated, are limited. At Carbon Cliff the seam was four or five feet thick, and for a time was worked with profit. But the deposit there seemed to be but an outlier and has now ceased to be mined to any extent. Traces of coal were also discovered in the bluffs opposite Cleveland, in the township of Hampton, and also further towards the east line of the county in the township of Zuma. At Coal Town, midway between Carbon Cliff and Camden, some old coal banks at the base, or near the base of the bluffs, in former years, furnished considerable coal, of a quality similar to that found at Carbon Cliff. It will thus be seen that coal and traces of coal, together with Coal Measure sandstones and shales, are more numerous north of Rock river than has been generally supposed. The northern edge of the great Illinois coal field rests unconformably upon the Hamilton and Niagara limestones from near Port Byron, on the Mississippi river, to where the bluff line abruptly trends north on striking the bottom of the Maredosia slough, and indeed north-east from thence to the sandstone quarries of Whiteside county on Cat-tail slough and north of Morrison. The triangular piece of elevated land east of Rock Island city, bounded by Pleasant Valley, Rock river, and the Mississippi river, is a mass of Coal Measure materials, resting upon a Devonian or upper Silurian foundation of underlaying limestones.

Building Stone.—Good building stone may be obtained from the Niagara and Hamilton limestones, at any of the outcrops of these formations. They both furnish a strong, rough material for common and massive masonry, but are difficult to dress into good shapes. The Le Clair limestone is softer and finer grained than the beds at Port Byron, but is undoubtedly only a variety of the same formation. The Niagara limestone further up the river is somewhat coarser in texturer, but is essentially the same rock. The Government arsenal on Rock Island is built of the Le Clair stone, but time has shown that it has not the requisite solidity for such massive work, and its use is now discarded in building the armory and the other public buildings in course of erection by the United States on that beautiful island. Some of the Coal Measure sandstones would make a fair building material, but as yet they have not been used extensively for that purpose.

The other geological deposits of economical value do not differ materially from those found in adjoining counties, and with the exception of fine potter's clay, may be passed without further comment. Associated with the Coal Measures about Hampton, and Carbon Cliff, and doubtless at many other places along these bluffs, is a very fine deposit of this clay.

A fair sized pottery at Hampton is kept running in the manufacture of common pottery ware. The clay is dug from the adjoining bluffs and hauled into the village, and made into crocks and jugs. It is here of a bluish, chocolate color, and makes a good article of common ware.

But the best establishment of this kind, perhaps, in this part of the State is located at Carbon Cliff, within a few hundred yards of the railroad station of the same name. Many years ago a company was formed for the purpose of mining coal in the Carbon Cliff bluffs. The company operated the mines, with varying success, until the coal practically became exhausted. The fine strata of potter's clay outcropping all along the exhausted coal seam then attracted attention. A pottery was started; patience, enterprise, energy and money, at last succeeded in building up from a small commencement a large and growing business. The buildings are of brick; the principal one is similar to a large, railroad round house, with a towering smoke-stack in the center. Around this has sprung up a little village, dependent for existence upon this single manufactory. More than eighty hands are constantly employed. The company have their own cars, which they load with their wares and attach to the passing trains; and in this way they supply the railroad towns over large portions of Northern Illinois and Iowa. Not only does this company manufacture the more ordinary crockery and pottery ware, but they devote much attention to making drain tiles, coarse table ware, terra cotta ware, garden ornaments, vases, and all similar articles. The company has met a marked and deserved success, and well illustrates what energy, skill and capital can make out of a bank of clay at one time supposed to possess no very great value. The associate clays of the Carbon Cliff Coal Measures are likely to possess a value far higher than the four feet of coal worked in former years.*

Rock Island County South of Rock River.

That part of the county lying south of Rock river contains five full townships and six pieces or fractions of regular townships, with an area of perhaps two hundred and sixty square miles. It is bounded north by Rock and the Mississippi rivers, west by the Mississippi, south by Mercer county, and east by Henry county. It has an average width of about nine miles from north to south, and a length from east to west of about thirty-three miles. The Mississippi river at Rock Island makes an abrupt bend to the west, and continues to flow in that direction for some twenty miles, where it turns south again, and thus almost washes the entire north and west sides of this part of the county.

The surface is diversified, and is made up of alluvial bottom land, hilly barrens, fertile and somewhat rolling upland prairies; the southern townships, and large portions of Coal Valley, Bowling, Edgington and Buffalo Prairie, are made up of the latter, under a higher degree of cultivation. These prairies are the handsomest part of the county, and gently roll away to the south and east, to the borders of Mercer and Henry counties. On the south side of Rock river, from the Henry county line to its confluence with the Mississippi below Rock Island city, is a strip of alluvial or bottom land, from one to two miles in width. Portions of this are swampy and boggy; others are sandy, with ridges of fine gravel and sand blows; and still others are rich farming lands, which yield heavy crops of Indian corn, grass and grains. Along the south side of this Rock river bottom the range of bluffs rise abruptly to an average of more than a hundred feet. At Andalusia the bluffs approach the Mississippi river, and this latter stream washes their base almost to the southern line of the county, except in a few places, where an uncultivated, low bottom intervenes, seamed with running sloughs. This range of bluffs is cut up with hollows and ravines; is covered with a moderate growth of timber, principally the oaks; the rough land, extending back into the highlands from two to five or six miles, has a thin, white soil, such as is found in the timber barrens of other portions of the State, and is altogether the least valuable portion of the county for agricultural purposes.

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*NOTE.—Since the above report was written, this establishment has been changed from a common pottery to the manufacture of drain tile; and the material used is obtained from the silicious shale that overlies the coal at this point. The shale is dug out where it lies immediately under the drift clays, and has been thoroughly exposed to drift influences, by which its lithological characters have been changed from a light gray shale to a silicious clay. The material used at Hampton, and formerly used here for pottery, is the under clay of the coal seam formerly worked at this locality. Several other beds of fire clay, apparently of good quality, occur in the lower Coal Measures in this county, and are mentioned in the local sections made at different points.

Geological Formations.

The geological formations consist of the drift clays and usual superficial deposits, the Coal Measures, including productive coal seams and associated shales, sandstones and limestones, and the Hamilton limestones.

The Hamilton Group.—The floor of Rock river from Camden almost to the Mississippi is composed of this rock. These massive paving stones as seen in the bottom of the river are irregular in size and contour, but are all worn smooth by the ceaseless flow of the strong, swift-running river. Their thickness at this place is unknown; the massive solidity, conchoidal fracture, and white dove color of the stone, indicate that it belongs to the lower part of the formation. At Lear's new mill, almost in the bed of Rock river, the workmen quarried into the solid stone floor of the river fifteen or twenty feet, with no signs of the bottom. Rock river runs over the same rocky floor of Hamilton limestone at and below Cleveland, near the eastern line of Rock Island county; also at its confluence with the Mississippi, below Camden. Between these points the river bottom shows a mud deposit, under which this same formation still probably might be found. Few fossils are found in the rock quarried from this river floor, either in Rock river or in the Rock Island rapids of the Mississippi.

The Mississippi river has a similar rocky floor from Port Byron almost to Muscatine. Horse-backs, hog-backs, and great rocky chains, characterize the rapids proper, but the lower part, from Rock Island city down, shows alternating stretches of mud, sand and rocky bottom. At some of the latter places navigation is rendered difficult at low stages of water. The Mississippi river bed from Rock Island to a few miles below Andalusia is composed of the lower member of the Hamilton group, being the same as the floor of Rock river at Camden. At Andulasia, in the edge of one of the Mississippi sloughs, just between high and low water mark, an excellent stone quarry is opened in this formation. The character of the stone quarried indicate that the quarry is opened in the upper division of the formation. The layers are not so massive as those found in the river; some of them are of a dove, and even light blue color, and fossils are abundant. Some large, thin slabs of flagging stone lying at this quarry were beautifully marked over the surface with groups and clusters of white encrinite stems, partially weathered out but firmly imbedded in the stone. At new Buffalo, the opposite steamboat landing, in Iowa, a similar stone quarry is extensively worked. Some of the pieces of stone thrown out of the bottom of these quarries presented a milky-white, and faintly bluish clouded color, and smooth conchoidal fracture: very unusual in stone thrown roughly from the quarry. The middle division of this formation, which outcrops between Moline and Rock Island in several places, was not observed south of Rock river. At the latter localities the color is a dirty-brown; the strata thin and broken up; many thin, shelly layers run through the mass, which disintegrate on exposure to the weather, leaving in the shaly clay thus formed a great abundance of fossil shells and corals. The little spring run, extending up from the stone quarry at Andalusia towards the residence of Dr. Bowman, runs over the top of the Hamilton limestone until it rises into the Coal Measures of the adjoining bluffs. In this little ravine finely preserved fossil shells and many cup-shaped corals may be obtained.

While speaking of the Hamilton group of this county and its development along the upper rapids of the Mississippi river, it might seem appropriate to notice the great amount of work now being done between Rock Island and Port Byron by the Government in the bed of the river, and to inquire as to its probable effect upon the depth of water in the Upper Mississippi. Large coffer dams are built in the stream, and a heavy force is employed at low stages of water in drilling, chiseling and blasting the rocky obstructions in the steamboat channel, and removing them. Steam and the best improved machinery are freely employed, and the work is making rapid progress. Some rivermen fear the effects of any deepening of the channel upon the supply of water above. This fear in all probability is ungrounded. The removal of obstructions, and the construction of wing dams with the material removed, will deepen the channel, by concentrating and raising the current, and will have no perceptible effect upon the waters of the upper river.

The Coal Measures.

All that part of Rock Island county south and east of the Mississippi and Rock river ranges of bluffs, is underlaid by the Coal Measures, which, as we have seen, rest near the two rivers, and for several miles back into the interior, upon the solid strata of the Hamilton limestone.

The Coal Measures all over the county are covered with a deep deposit of drift-clays. At Camden, Carbon Cliff, and east of Rock Island city, this drift-clay is from forty to seventy-five feet thick.

A section made at the Coal Valley coal mines, south of Rock river, and seven or eight miles in the interior of the county, gives the following section:

No. 1.	Reddish and yellowish drift-clays	30 feet.
No. 2.	Silicious shale	10 "
No. 3.	Band of chert	2 "
No. 4.	Dark bluish-gray, silicious limestone, shaly at the top and massive at the bottom	10 to 18 "
No. 5.	Bituminous shale	1 " 3 "
No. 6.	Coal No. 1, average thickness	4½ "
No. 7.	Fire clay, passing downward into shale	12 "

Up a ravine in the bluffs, midway between Camden and Andalusia, a dark-colored massive sandstone is quarried to some extent. The outcrop is about ten feet thick, and the stone is clouded and stained with iron. Below Andalusia, near the mouth of Coal creek, a little stream which comes down from the bluffs, is an outcrop about twenty feet thick, of a massive, close-grained, umber colored magnesian limestone, which has been quarried to a considerable extent. From thence down the bluff line to Drury's landing, both sandstones and limestones show themselves low in the hills, but none of these outcrops have been worked to any extent. Opposite Muscatine, a somewhat massive sandstone outcrops, which has been worked, and in which has been found several fine specimens of *Lepidodendron.* Near Copperas creek, in the eastern part of the township of Drury, there is also a sandstone quarry worked to some extent.

South of rock river, the Coal Measures are more regular and more extensively developed than in the northern part of the county, and at least three of the lower seams were recognized. At Coal Valley, and near the base of the hills in the vicinity of Andalusia, coal No. 1 may be seen with its black shale and limestone roof, and its characteristic band of chert; and further back in the hills of Coal creek, Walnut creek and on Big run, coals No. 2 and 3 were identified, and have both been opened, and are now worked for the supply of the local market. Nevertheless, more than nine-tenths of all the coal mined at the present time in this county comes from the lower seam. The Coal Valley mines are among the oldest worked in this portion of the State, and to the present time they have furnished the largest portion of the coal used at Rock Island and Moline, and the country further north. Where fully developed as a single seam, its thickness is about five feet, but it is sometimes divided by a shaly parting, and the two divisions become too widely separated to be worked together. It has an excellent roof of black shale and hard blue arenaceous limestone, overlaid by a band of chert, which at one point attains a thickness of about two feet. This is succeeded by silicious shale and sandstone, extending upward to the fire clay or septaria-like limestone below coal No. 2.

The limestone over this coal splits into irregular conchoidal fragments on exposure to atmospheric influences, and at Coal Valley, and at some other points is filled with a peculiar fucoid resembling the *Cauda Galli* of the Devonian rocks. The black shales over the coal afford some fossils, among which the *Productus muricatus* and *Chonetes mesoloba* were common, and associated with them we obtained *Discina nitida*, *Rhynchonella Eatoniæformis*, *Lima retifera*, *Petrodus occidentalis* and *Listracanthus hystrix*. Undetermined species of *Nautilus*, *Orthoceras*, *Aviculopecten* and *Pleurophorus* were also obtained here.

An analysis of this coal, from a specimen taken from the Carbon Cliff mines, is given on a preceding page, and shows about the average quality of this seam in the vicinity of Rock river.

About three miles north east of Coal Valley, and just over the line in Henry county, on the S.W. qr. of Sec. 19, T. 17 N., R. 1 east, this seam has been opened and is now worked at what is known as the Parks mines. The coal is here about five feet thick and of excellent quality, breaking into regular quadrangular pieces. The chert band over the coal is a foot or more in thickness at this point, and the beds of the little runs are full of its broken fragments.

On Walnut creek, which empties into the Mississippi just below Andalusia, about one hundred feet in thickness of Coal Measures may be seen directly overlaying the Devonian limestone. The beds exposed here show the following succession :

No. 1.	Clay shales passing upward into sandy shales, the lowest layers bituminous	8 to 10 feet.
No. 2.	Coal, No. 2	1½ "
No. 3.	Fire-clay	2 to 3 "
No. 4.	Sandy shales and sandstone	20 " 30 "
No. 5.	Dark-blue silicious limestone	1 " 3 "
No. 6.	Bituminous shale	4 " 8 "
No. 7.	Coal, No. 1	3 "
No. 8.	Fire clay	2 " 3 "
No. 9.	Shales, argillaceous, silicious and partly bituminous, with a thin seam of coal	50 " 60 "
No. 10.	Devonian limestone—exposed	10 "

The upper coal seam in the above section had been opened at one point in the bluffs of the creek, but proved to be too thin to be profitably worked, and was subsequently abandoned.

On Coal creek, another small stream still further south, there are about two hundred feet of Coal Measures to be seen, which probably include the horizon of the three lower seams of coal. The section here shows about the following order :

No. 1.	Sandy shales	30 to 40 feet.
No. 2.	Bituminous shale, with about one foot of coal near the middle of the bed (No. 3?)	8 " 10 "
No. 3.	Sandstone, thin bedded in the upper part and thicker below	30 " 40 "

No. 4.	Bituminous shale (Coal No. 2 ?)		3 to 4	feet
No. 5.	Fire-clay		2 " 4	"
No. 6.	Sandy, argillaceous and bituminous shale		50	"
No. 7.	Bituminous shale		3	"
No. 8.	Coal	No. 1	1	"
No. 9.	Sandstone, filled with *Stigmaria*		6 " 8	"
No. 10.	Coal		2	"
No. 11.	Sandy shales and thin-bedded sandstones partially exposed		60 " 70	"
No. 12.	Brown magnesian limestone, Devonian		10	"

Neither of the coal seams appear to be well developed on this creek. No. 1 is divided, and the divisions are so widely separated that they cannot be worked together, and are both too thin to be profitably worked as separate seams. No. 2 is represented by a bed of bituminous shale, and No. 3, if represented at all in this section, is only about a foot thick, and intercalated in a bed of bituminous shale. I am rather inclined to the opinion, however, that No. 2 of the foregoing section is only a local development, and that No. 3 coal lies above the sandy shales forming the top of the section, and if found at all on this creek will be immediately below the drift.

On Big run near Brownsville a coal has been opened near the top of the hill which I believe to be No. 3 of the Illinois river section. The seam is here about three feet in thickness, and is overlaid by a few inches of bituminous shale passing upward into a brown sandy shale. The slope of the hill below this seam for a distance of nearly a hundred feet was so completely covered that no section of the underlaying beds could be made here. The coal afforded by this seam was rather hard and slaty and inferior in quality to that usually obtained from either of the lower seams. About half a mile up the creek from this coal bank, the following beds outcrop below the drift clays that cap the hill:

		Feet.
No. 1.	Shale, sandy	3
No. 2.	Hard quartzose sandstone	3 to 4
No. 3.	Fire-clay	4
No. 4.	Shales partly argillaceous and partly sandy	30 to 40

The sandstone No. 2 of the above section is an excellent and durable stone for heavy masonry, and the creek bed is full of large blocks of it, on which the elements seem to have no effect. The Brownsville coal probably overlies the beds in the foregoing section. The beds in this vicinity are the highest Coal Measure strata that we found exposed in this county, and as the distance from No. 3 up to No. 4 is usually from 75 to 100 feet, it is hardly probable that any coal above No. 3 will be found in the county.

From the preceding section it will be seen that the coal seams of this county are very irregular in their developments, and, with the exception of No. 1, do not promise to be of much value in the production of coal. However it is quite possible that at some localities remote from the river bluffs, or away from the principal streams, the upper seams may be found more fully developed, and this may be tested at any point in the county where the demand for coal may seem to justify the experiment, by boring down to the Devonian limestones, which will be reached anywhere in the county at a depth probably not exceeding 300 feet.

About seven miles below Andalusia, and in the neighborhood of Illinois City, coal is worked by a Mr. Arnold, by drifting into the Mississippi river bluffs. Here the seam is almost four feet thick, and the quality of coal about same as at the mine worked by Mr. Smith, east of Andalusia. On Copperas creek, in township 16, range 5, the same seam, I think, is reached by a shaft of moderate depth.

The Coal Valley mines have been worked for many years and have made their present proprietors wealthy. Some ten years ago a railroad was built from Coal Valley to Rock Island city, with depots and all the appurtenances of a first class road. A village of eighteen hundred inhabitants has sprung up round the mines. From sixty to one hundred miners find constant employment, and two hundred and fifty tons per day are sent to Rock Island when the mines are worked with the latter number of hands. This coal is sent into Iowa and Northern Illinois, but is used principally for making steam on the Mississippi river, for which purpose it seems well adapted. The working of these mines, the transportation of the coal to the river, and the capital or ownership of the mines, is all under a sort of a triune arrangement, which, under the energetic supervision of the Messrs Cable, seems to work admirably. The coal company, the railroad company, and the miners each receive one-third of the coal mined, or profits realized. A perfect community of interest is thus kept up, and strikes and dissatisfaction are comparatively unknown.

The coal seam is from four to four and a half feet thick. It is subject to local dips and elevations, sometimes dipping below the water level. Faults or "horsebacks" are struck when the drifts extend far into the hills. Beyond these so-called faults, sometimes only black shales are found, and sometimes the coal seam becomes too thin to work. The roof is composed of black shales, in places rotten, and is succeeded by dark, irregularly-bedded limestone, of slaty cleavage and conchoidal fracture. In one or two instances, for short distances the seam is double, being separated by several feet of dark shales and other foreign matter. The floor of the seam sometimes consists of an impure fire-clay, and in other places of a black slate, with some resemblance to cannel coal. Wooden railways are laid in the drifts, and the coal is hauled out by mules and wooden cars, and dumped directly into the railroad cars at the station. Some of the hills are tunneled pretty thoroughly, and the supply of coal well nigh exhausted in them, but new drifts, and farther extensions of old drifts, will doubtless afford profitable mining for some years to come. The deposit however is quite local in extent, and will some day become exhausted. In 1867 sixty-eight thousand tons of coal were mined, and sent to market; in 1868 the amount was probably larger. This, in time, will exhaust any small coal field.

The coal itself is a fair, soft coal, tolerably free from sulphur, and stained red in places with the rust of iron from the percolating waters. It is well adapted to making steam, for which purpose it is extensively used.

This seam nowhere perhaps rests directly upon the Devonian rocks, as in Henry county, near Cleveland, but is separated therefrom by sandstones and shales, some twenty to sixty feet and upwards in thickness.

The coal seams of Rock Island and adjoining counties along the northern boundaries of the Illinois coal fields belong to the lower Coal Measures of the State. The Silurian rocks dip very gradually, the angle being almost imperceptible, beneath the Coal Measures. At the south-west corner of Rock Island county the sub-Carboniferous limestone probably underlies the Coal Measures; at the mouth of Rock river the Hamilton limestone does the same; farther up the river at Aldrich's the Niagara limestone is the underlaying rock; and along the northeastern part of Bureau county the Galena limestone may be detected in the same position.

Drift Deposits.—The usual Quaternary deposits are found in this part of Rock Island county. In the south-west corner there is a strip of alluvial bottom along the Mississippi river. On the south side of Rock river the usual alluvial river bottoms extend across the whole county, intersected with some low ridges of sand. Both these strips are inclined to be swampy, except some portions of the latter, which are dry enough to make excellent farming lands. The loess of the bluffs is not very distinctly marked. A heavy deposit of light colored drift clays overlays the Coal Measures, attaining a thickness of fifty or sixty feet. Occasional boulders are seen on the surface, or in the ravines. Gravel beds and coarse gravel are not met with. No very marked drift phenomena were noticed, and the drift deposits of the southern part of Rock Island county present no peculiar or marked characteristics.

Economical Geology.—Of coal, the extent of its mining, and its probable supply, we have spoken already in a former part of this report. The importance of the coal traffic in the future history of this county can hardly be over-estimated. The facilities for distribution from Rock Island into Northern Illinois and Iowa, and the great demand and easy access to the Rock Island coal field for fuel to make steam on the Mississippi river, create a steady demand for very large quantities of coal. The construction of a railroad up the valley of Rock river, and eventually into the lumber regions of Wisconsin—a work now actively agitated, and in part commenced and under contract—will greatly add to this demand.

The other economical deposits do not differ materially from those of the northern part of the county. Abundance of good stone are found along the two rivers for building purposes. The drift clays burn into a good common brick. The purer strata of the Hamilton limestones make an excellent and very white article of common lime. The rougher portions of the surface are well adapted to the cultivation of the cereals, the vine, and other varieties of Illinois fruits. The county as a whole has many sources of material prosperity, although its agricultural resources are far from being equal to those of some of the neighboring counties.

Mineral Springs.—I should not close this report without speaking of a very remarkable group of mineral springs just below the village of Andalusia. They are known as the "Rinnah Wells Springs." Two or three of them are curbed with stone. The water flows out of the top, and leaves a whitish incrustation on the curb stones. It has a strong, rather pleasant, soda taste, and is said to contain marked medicinal and health-giving properties. The water is far more pleasant to the taste than that afforded by the springs at Saratoga and other fashionable resorts in the Eastern States; but the probability is that there are no better or more health-giving mineral waters to be found in our country than those welling up from these "White Sulphur" or "Soda" springs. Andalusia has a musical name, is surrounded with varied and handsome scenery, and as a pleasant resort during portions of the year would prove attractive. A little wealth and a little advertising would make this a desirable stopping place for pleasure seekers on the great thoroughfare of the Mississippi, and would attract the invalids from this and the neighboring States.

NOTE.—In closing our report on this county we desire to acknowledge our obligations to WM. S. THOMAS, of Carbon Cliff, and to Mr. BUFFUM, of Andalusia, for the hospitable entertainment which they so freely extended to us while at work in the county; and to Mr. RINNAH BUFFUM, Mr. S. C. BOWMAN, J. H. SOUTHWELL, and Dr. COZAD, of Andalusia, for their valuable contributions of the interesting fossils of this region, and their earnest co-operation and assistance while at work in the southern part of the county.
A. H. W.

CHAPTER XIV.

PEORIA COUNTY.

Peoria county lies about seventy-five miles north of the center of the State, and is bounded on the north by Stark and Marshall counties, on the east by the Illinois river, on the south by the Illinois river and Fulton county, and on the west by Fulton and Knox counties. It embraces an area of fourteen full townships and seven fractional townships bordering the Illinois river, or about six hundred and thirty square miles. The Illinois river extends for about fifty miles along its eastern and south-eastern borders; Kickapoo creek and its several affluents traverse the central portion of the county; while Spoon river intersects the north-western townships for a distance of ten or twelve miles.

The surface of the county was originally nearly equally divided into timber and prairie. The prairies are usually small, the most extensive ones being those in the western and northern portions of the county, and extending over the highest lands between the water courses. There is also a narrow strip of prairie extending along the river from the north-east corner of the county to the outlet of the Kickapoo, having a variable width of from one to three miles. This belt of prairie covers a sandy terrace below the river bluffs, and is elevated from thirty to fifty feet above low water level.

Surface Geology.

Four sub-divisions of the Quaternary are found in this county: alluvium, loess, modified drift, and the true drift or boulder clay. The alluvial deposits are of limited extent, and confined to the borders of the principal streams. The terrace lands, on the southern extremity of which the city of Peoria is built, and which extend thence to the north-eastern extremity of the county, may be considered as belonging to the modified drift deposits rather than the alluvium. Their surface is entirely above the high water level of the river, and they consist largely of sand and gravel, which was deposited during what may be termed the terrace epoch, when the waters in the valley of the Illinois stood at a level of fifty feet or more above the highest point attained by the waters of the existing streams, but still subsequent to the accumulations of modified drift that forms the main portion of the bluff at Peoria, and along the north bank of the Kickapoo for some distance beyond Edwards station. These sandy terraces occurring at about the same level, are a characteristic feature of the Illinois river valley, and most of the towns from Naples to Peru are built upon them. We were not able to obtain any reliable section of the beds constituting this terrace, but so far as could be seen from partial exposures of the strata on the small streams that cut through it, the upper portion at least is composed mainly of sand and gravel.

The modified drift deposits, which form the main portion of the bluff at Peoria, are about seventy five or eighty feet in thickness; and for the following section, made in sinking a well from the top of the bluff in that city, I am indebted to my friend E. G. Johnson, esq. The well was four feet in diameter, and was carried down ninety-seven feet, and then a boring was made eight feet more. The section is as follows:

No. 1.	Brown prairie clay and soil	12 feet.
No 2.	Coarse gravel and sand, with boulders	35 "
No. 2.	Clay and sand, forming seven or eight distinct beds, some containing coarse gravel and boulders	48 "
No. 4.	Black, mucky soil, with limbs of trees, etc	2 "
No. 5.	Boulder clay	8 "

Nos. 2 and three constitute the modified drift deposits of this section, and their aggregate thickness is eighty-three feet. Mr. Johnson remarks, in his letter transmitting this section to me, that "at the depth of about eighty feet from the surface we found a considerable heap of charcoal: evidently such as would be left by a fire made of branches of trees from a half inch to an inch in diameter; a small fire, big enough to have boiled a kettle or cooked a venison steak." This proves conclusively the existence of man in this region anterior to the epoch of the modified drift, and we may reasonably expect that evidence will yet be found to prove his existance here anterior to the deposit of the boulder clay. No. 2 of the foregoing section contains boulders of all the varieties of metamorphic rocks usually occurring in our drift deposits, and of all sizes up to a diameter of three or four feet. The full extent of this deposit inland from the river bluffs we were unable to determine, but it extends westward to the valley of the Kickapoo, and northwardly it is exposed on all the branches intersecting the bluffs for several miles. The ancient valley now in part occupied by the Illinois river was apparently at one time fully twice its present width from the outlet of the Snatchwine to the Kickapoo, and its western portion has been subsequently filled with these drift accumulations. In the north-eastern portion of the county the drift beds presented no decided indications of having been subjected to the modifying influences observed further south, and they attain a greater thickness here than in any other portion of the county. In the bluffs west of Mossville they are fully two hundred feet thick, as shown by measurement where the road leading out to the prairie ascends the bluff, and consist of brown and dark-bluish colored clays, with gravel and boulders. The upper portion of this deposit here is a brown clay, comparatively free from gravel, and thirty to forty feet thick. Striking the prairie road about three miles west of Mossville, and turning south to Peoria, no indications of the presence of any stratified rocks were seen in any of the gulches intersecting the bluffs, although careful examinations were made. Hence we may safely conclude that the western borders of the old valley in this vicinity were at least three miles to the westward of the present line of bluffs.

On the south side of the Kickapoo, and in the central and northwestern portions of the county, the stratified rocks of the Coal Measures outcrop on all the streams, and the overlaying drift beds are comparatively thin, ranging all the way from four to sixty feet. At Chase's quarries, three miles north-east of Princeville, the drift clays are only from three to four feet thick, with about a foot in thickness of sand resting directly upon the limestone; and at several other points in this vicinity the bed rock was seen outcropping within a few feet of the surface. It is probable this limestone formed a barrier reef during the accumulation of the drift, and the transported material was thus diverted into the deeper channels on either side. South of the Kickapoo the uplands are covered with drift clays, that are generally from forty to fifty feet in thickness and spread quite uniformly over the surface. Along the river bluffs the marly, buff colored beds of the loess cap the highest points, but north of the Kickapoo we did not meet any beds that could be properly referred to this age, unless the brown clay immediately below the soil may be so referred.

The only fossils of this age that have come under my notice from this county are the remains of a mammoth, consisting of two molar teeth, with a portion of the jaw, which was found by Captain Smith in the gravel bed No. 2 of the foregoing section, in the Peoria bluff. A portion of one of these teeth, with a part of the jaw, now belongs to the State cabinet, as a contribution from its discoverer. In a boring made near Chillicothe a few years since, an ancient copper coin was reported to have been found at a depth of 122 feet, but it might have been dropped in from the surface for the purpose of deception, or fallen down accidentally from some layer near the surface. This coin has been figured and described in the Transactions of the American Philosophical

Society of Philadelphia, vol. xii., p. 224. Although it is by no means improbable that primeval man existed before the valley drift of this region was deposited, yet we have no evidence going to show that he was then so far civilized as to be able to work the native metals, or to have acquired any knowledge of the use of money.

Stratigraphical Geology.

All the stratified rocks that appear above the lowest water levels in this county belong to the Coal Measures, and comprise an aggregate thickness of about 175 feet, including the horizons of coals No. 4 to 7, inclusive. Three of these seams, Nos. 4, 6 and 7, are worked extensively, in various portions of the county, and have an aggregate thickness of about twelve feet.

The following section, constructed from the outcrops of the strata along the Kickapoo creek and its branches, will illustrate the thickness and relative position of the various coals in this county, and the rocks with which they are associated:

No. 1.	Seam of smut, indicating a thin coal, or black shale	1	feet.
No. 2.	Soft brown sandstone, partly exposed	15 to 18	
No. 3.	Gray limestone, upper portion nodular and impure	15 to 20	'
No. 4.	Sandy and argillaceous shales	45	
No. 5.	Bituminous shale	3 to 5	
No. 6.	Coal, No. 7	1½ to 3½	
No. 7.	Sandy shales	30 to 35	
No. 8.	Light gray limestone, with *fusulina*	2 to 4	
No. 9.	Bituminous slate and shale	1 to 2	
No. 10.	Coal, No. 6	3 to 5	
No. 11.	Shales, argillaceous and sandy	20 to 35	
	Horizon of coal No. 5.		
No. 12.	Sandstone, partly ferruginous, passing upward into shale	28 to 30	
No. 13.	Bituminous and arg. shale, with iron stone concretions	5 to 8	
No. 14.	Coal No. 4	4 to 5	"
No. 15.	Fire clay and septaria	2 to 3	"
No. 16.	Argillaceous and sandy shales	15 to 20	"

The three upper beds in the foregoing section, especially the limestone, is well exposed at Mr. John Lonsdale's quarries, on the south side of the Kickapoo valley, on section 14, town 8 north, range 7 east, (Limestone township.) The lower layers of this limestone are quarried here both for building stone and for burning into lime. This part of the bed affords tolerably even layers, from four to eight inches thick, of fine-grained, compact, light-bluish gray limestone, that makes a very good building stone and also a quicklime of fair quality. The upper portion of the bed is in very uneven nodular layers of an inch or two in thickness, and on weathering becomes a loose mass of limestone pebbles, of about the proper size for macadamizing material. *Spirifer lineatus* and *Athyris subtilita* were the most common fossils found in these upper layers, and these, with *Spirifer cameratus*, *Retzia punctulifera* and *Platyostoma Peoriense*, were obtained from the lower beds. WILLIAM GIFFORD, Esq., obtained here a magnificent specimen of *Chætetes milleporaceous*, about two feet in diameter, by far the largest specimen of the kind yet found in this State. It came from the lower part of the limestone, or perhaps from the clay-shales which underlie it.

The beds overlaying the limestone we found but partially exposed in the vicinity of St. John's church, where a quarry had been opened showing a face of about five or six feet of thin-bedded soft brown sandstone, and above this some partial outcrops of sandy shale. In the side of the road nearly opposite the church, the seam of smut was found which we have placed at the top of this section, but whether it was derived from a rotten coal or a bituminous shale, could not be determined without further exploration. It lay immediately under the boulder clay, and had probably been for a long time subjected to atmospheric influences before the drift-clays were deposited upon it. It is not probable that it represents a coal seam of any considerable thickness: otherwise it would have been discovered in sinking wells in this vicinity, as the outcrop was not far below the general level of the prairie. The bed No. 4 of the foregoing section is usually an arenaceous shale, but locally it becomes partly argillaceous, and affords some fine specimens of silicious wood, that are found in the beds of the small streams that cut through it, and probably come from the argillaceous layers of this bed. On one of the branches of the north fork of the Kickapoo creek, on section 4, in Jubilee township, there is an imperfect exposure of the following beds, all of which seem to belong above the horizon of coal No. 7:

No. 1.	Brownish gray limestone	2 to 3 feet.
No. 2.	Green and yellow argillaceous shales	20 to 30 "
No. 3.	Limestone conglomerate	2 "
No. 4.	Sandy shales partially exposed	15 to 20 "

The ravine where this section was made abounds with fossil wood, all of it completely silicified, and many of the specimens representing sections of what were once large trees; many of the fragments are now from two to three feet in length, and so large as to require the strength of two stout men to load them into a wagon. Several wagon loads of this silicious wood could have been obtained from this ravine in a distance of two or three hundred yards. Although not found *in situ*, it no doubt came from the argillaceous shales represented by No. 2 of the above section, as it seemed to be most abundant along the outcrop of this bed. We found one fine specimen on the south side of the Kickapoo at about the same horizon, but the shales are there more arenaceous, and the specimens of fossil wood comparatively rare. The limestone conglomerate, No. 3 of the above section, was not seen on the south side of the

Kickapoo, but it seems to correspond very nearly in position to a band of sparry limestone at the top of the section at Kingston, given on a following page.

On section 18, in Radnor township, we found a single layer of fine grained gray limestone about thirty inches thick, traversed by thin veins of spar, which may be the equivalent of No. 3 of the above section, but as there was no exposure of the underlaying strata, its position could not be positively determined. Below it we only saw a few inches of pebbly clay resembling a fire clay.

Coal No. 7 is quite variable in thickness in this county, ranging from one and a half or two feet on the waters of the Kickapoo, to three and three and a half feet in the north-eastern portion of the county. On the Kickapoo but few attempts have been made to work it in competition with the thicker seams which underlie it and outcrop in nearly every hill side, but in the northern part of the county this coal ranges from three to three and a half feet in thickness, and as the lower seams are there below the surface, this is mainly relied upon for a local supply of coal. Armet and Dukes mines, two and a half miles north west of Chillicothe, are on this seam, and the coal is there thirty inches thick, over laid by a rather soft bituminous shale about two feet in thickness. The beds exposed at this point give the following section:

No. 1.	Sandy ferruginous shales	35	feet.
No. 2.	Bituminous shale	2	"
No. 3.	Coal No. 7	2½	"
No. 4.	Sandy shales and sandstone	20 to 25	"
No. 5.	Arenaceous limestone	2	"
No. 6.	Bituminous shale	1 to 3	"
No. 7.	Coal No. 6	below the level of the creek.	

On Mr. Hunter's land, a little farther to the westward on the same branch, the coal is three feet thick, with about the same thickness of bituminous shale above it. It is also worked on the Snatchwine and at Hallock's hollow five miles west of Chillicothe, but I did not visit these localities. The shales overlaying the coal on Hunter's land contains numerous iron-stone concretions very similar in appearance to those found on Mazon creek in Grundy county, but they contain no fossils here so far as I could discover. Coal No. 6 is reported to be very irregular in its development in this vicinity, and hence no systematic attempt has been made to work it here.

Coals No. 4 and 6 outcrop in the river bluff below the valley of the Kickapoo and also in the bluffs on either side of that stream nearly to Edwards' station, where No. 6 gradually passes underneath the creek valley. At Kingston, in the extreme south-eastern portion of the county, both seams have been worked since the earliest settlement of the county, and the mines here were among the first opened for supplying coal to the river steamers. When we first visited this locality in 1859 the upper seam (No. 6) was worked by Mr. John D. Jones, in a tunnel driven horizontally into the bluff on the outcrop of the seam. The coal averages about four feet in thickness and has a good roof of bituminous shale and limestone.

No. 4 was also worked at this time by the Kingston Coal Company, in a horizontal tunnel driven into the base of the hill. The thickness of the coal in this seam ranges here from four to four and a half feet, and the coal is much harder than that in the upper seam and is a good steam coal, but contains more pyrite than No. 6, and is consequently not a favorite coal with the blacksmiths.

At Lancaster landing, one mile and a half below Kingston, both seams have been opened, and the lower one has been constantly worked for several years. Its thickness here is from four and a half to five feet, with a roof of bituminous shale one foot thick overlaid by shale and sandstone. Below the coal there is from one to two feet of dark-blue fire-clay, underlaid with shale containing bands of septaria. From the roof shales of this seam we obtained the following fossils at the various mines in this part of the county: *Lingula umbonata? Discina-nitida*, *Athyris subtilita*, *Aviculopecten rectalaterarea*, *Petrodus occidentalis*, *Listracanthus hystrix*, *Pleurotomaria Grayvillensis*, and joints of *crinoidea*, some of the latter being more than half an inch in diameter.

At Liverpool, No. 6 is mined to supply steamers at that point, as No. 4 is below the level of the bottom lands. The roof of this seam is usually a foot or more of bituminous shale, overlaid by from two to three feet of brownish-gray argillaceous limestone. The characteristic fossil of this limestone is a small *Fusulina*, about the size and form of a grain of wheat, but associated with it we find *Productus longispinus*, *P. costatus*, *Hemipronites crassus*, *Chonetes mesoloba* and joints of *crinoidea*. The coal in this seam is not so persistent in its development as that of No. 4, being more effected by the irregularities usually termed "horsebacks" by the miners, by which the coal is partly or wholly replaced with shale or fire-clay. This forms the great impediment to the successful mining of this seam at the present time. The following section of the strata outcropping at Kingston was made on my first visit to the locality in 1859:

No. 1.	Sparry brownish-gray limestone	2 feet.
No. 2.	Shales, sandy and argillaceous	12 to 15 "
No. 3.	Coal No. 7	1½ "
No. 4.	Fire-clay	2 "
No. 5.	Sandstone and shale	20 to 25 "
No. 6.	Limestone	2 to 3 "
No. 7.	Bituminous shale	1 to 3 "
No. 8.	Coal No. 6	3 to 4½ "
No. 9.	Fire-clay	2 to 3 "
No. 10.	Sandstone and sandy shales	35 to 40 "
No. 11.	Blue clay shales with bands of ironstone	10 to 15 "

No. 12.	Bituminous shale	3 to 5 feet
No. 13.	Coal No. 4	4 to 4½ ''
No. 14.	Fire-clay with septaria	2 to 3 ''
No. 15.	Shales partially exposed to river level	20 ''

Previous to this time a boring was made here, no accurate record of which was kept, but a coal seam three feet thick was reported at a depth of about one hundred and fifty feet below the lower seam in the above section, and as that is about the depth at which No. 2 would probably be found, the report is by no means improbable. From the careless manner in which borings were made at this time, and the incompetency of those most frequently placed in charge of this kind of work, but little dependence should be put upon the reported results.

At the Mapleton mines, the first now in operation north of Kingston, the coal in No. 4 is somewhat thicker than its general average in this county, being, according to the report of the mining engineer, from five feet to five feet ten inches in thickness. This seam is also less subject to interruption from "horsebacks" here, than in some of the mines further north, and where they do occur they are usually of limited extent. These mines have been opened in the most substantial way, the entries are spacious and thoroughly secured with heavy timbers, and the work is prosecuted in the most thorough manner.

At the Orchard and Hollis mines, opposite the city of Pekin, the same seam is worked, and the coal is from four feet to four feet ten inches thick with a very good roof of bituminous shale. A "horseback" has been encountered in these mines, so extensive, as to lead some of the miners to the conclusion that a true fault or dislocation of the strata occurred here, but from such examinations as I was able to make, both in the mines and the adjacent ravines, where conclusive evidence of a fault ought to be apparent if one existed, I came to the decided conclusion that no dislocation of the strata had taken place, but that the coal had perhaps been cut away by the action of water currents, and the clay deposited in its place, and that when it was found on the other side of this so-called "fault" it would be found at about the same level with the coal now worked in the mine. On one of the ravines immediately west of these mines, we were shown a locality where the rocks had apparently been partially undermined by the erosive agencies that formed the valley, and the strata of sandstone and shale above the coal having partially fallen, dipped to the eastward at a high angle, and this was regarded by some as conclusive evidence of the occurence of a fault in this vicinity. But if this was the case, and this apparent dip continued to the Orchard mines, it would carry the coal seam far below its present level, and probably even below the level of the Illinois river, while on the contrary the coal in these mines lies nearly horizontal, and is, moreover, on about the same level as in the mines on either side. Hence we feel confident the irregularity in the deposition of the coal here is not due to any dislocation of the strata, but must be accounted for on some other hypothesis. No systematic attempt has yet been made in this neighborhood to work No. 6, but its outcrop is continuous along the face of the bluff, at an elevation of about sixty-five feet above No. 4. The coal afforded by this lower seam is considered to be somewhat softer and freer from pyrite at the mines along the Illinois river bluffs, than on the Kickapoo, which is perhaps, in part, the reason why the upper coal has been so generally neglected here.

Commencing on the south side of the Kickapoo, we find continuous outcrops of these two seams in the bluffs of that stream for several miles to the westward, until the elevation of the valley towards the head of the stream brings it above the level of these coals, and No. 7 is the only seam remaining above the level of the water courses. On the north side of the creek the outcrops are not continuous, the coal strata being partially removed by erosion, and their place subsequently filled with deposits of modified drift.

Walter Treasure's mine is on the south bluff of the Kickapoo, on the south-east quarter of section 24, township 8 north, range 7 west. No. 4 is the seam worked here, and it ranges from four feet to four feet two inches in thickness, with a roof of bituminous shale passing upward into a blue clay shale with bands of iron ore. The coal is hard and bright, and is not much interrupted by "horsebacks," and is underlaid by a foot or more of gray fire clay passing downward into a clay shale with bands of limestone. This mine, like all the others in this part of the county, is worked with a horizontal tunnel driven into the base of the hill on the line of outcrop.

The following section, compiled from the exposures of the strata seen in this vicinity, will, by comparison with those heretofore given, show how uniformly these two coals and the strata associated with them are developed in this part of the county:

No. 1.	Light-gray limestone	2 to 3	feet.
No. 2.	Bituminous shale	1 to 2	"
No. 3.	Coal, (No. 6)	3 to 5	"
No. 4.	Clay shale or fire clay and nodular limestone	3 to 6	"
No. 5.	Sandy shales	25 to 30	"
No. 6.	Massive micaceous and ferruginous sandstone	20	"
No. 7.	Blue shale with iron bands	6 to 8	"
No. 8.	Bituminous shale	1 to 3	"
No. 9.	Coal, (No. 4)	4	"
No. 10.	Fire clay	2	"
No. 11.	Shale with thin bands of limestone	15	"

Coal No. 5, if developed here, would be found near the bottom of the sandy shales No. 5 of the above section, but we found no indications of its presence at any of the localities visited by us in this county.

At Griswold's mines, on the north-west quarter of section 24, township 8 north, range 7 west, coal No. 4 is from four feet to four feet six inches in thickness, with the same kind of a roof as at Treasure's mines, and the coal is similar in quality.

No. 6 has been opened at many points in this vicinity, but from its uneven development and its greater elevation above the creek valley, it is not mined as systematically as the lower seam. The sandstone No. 6 of the above section is well developed along the Kickapoo bluffs in this vicinity, and some extensive quarries have been opened here. The rock is partly a brown micaceous, and partly a ferruginous sandstone, in massive layers from one to three feet in thickness. The ferruginous layers become quite hard on exposure, and will no doubt resist the disintegrating influences of the atmosphere more effectually than any other portions of the bed, but if carefully selected and the soft and shelly portions of the rock rejected at the quarry, the remaining portion will no doubt sustain a good reputation as a reliable building stone.

On a ravine about half a mile west of Monroe's mill, coal No. 7 was found high up in the hill. It is here only about eighteen inches in thickness, and is separated from No. 6 by about thirty-five feet of sandy and argillaceous shales. It was overlaid by bituminous shale and a soft micaceous sandstone.

At Edwards' station, on the Peoria branch of the Chicago, Burlington and Quincy railroad, coal No. 4 is some sixty feet below the level of the valley, and No. 6 is worked by a horizontal tunnel into the base of the hill just above the railroad grade. As at the outcrops of this seam further west, it is quite variable in thickness here, ranging from three to five feet, and, in consequence, it cannot be mined as cheaply as No. 4.

About a mile south of Elmwood, coal No. 6 is reached by a shaft fifty feet in depth. The coal is four feet to four feet and a-half in thickness, with a few inches of bituminous shale, and a light-gray sandstone forming the roof. The coal is tolerably soft, light and free burning, and generally free from pyrite. Coal No. 7 outcrops in this vicinity and has been worked in a limited way, but is too thin to be mined successfully in competition with the lower seams. A boring near Elmwood, on the south side of the Kickapoo, struck the bed rock at sixty feet and below the horizon of coal No. 6, and was carried down through the following strata:

No. 1.	Drift clay	60	feet.
No. 2.	Clay shale	18	"
No. 3.	Limestone	2	"
No. 4.	Bituminous shale	2	"
No. 5.	Coal. (No. 4)	3½	"
No. 6.	Sandy shale	15	"
No. 7.	Septaria	7	"

No. 8.	Clay shale	24	feet.
No. 9.	Nodular limestone	8	"
No. 10.	Gray shale	28	"
No. 11.	Blue limestone	2	"
No. 12.	Dark shale	12	"
No. 13.	Bituminous shale	2	"
No. 14.	Coal, (No 3)	3½	"

This boring was made by the Elmwood Mining and Manufacturing Company, and I am indebted to W. J. Phelps, Esq., of said company, for the details here given. By comparing this section with that of Voris & Co., on the east bank of the Illinois river opposite Peoria, as given in Vol. IV, p. 180, it will be seen that the beds below No. 4 coal thicken somewhat to the eastward, as it was found to be about one hundred and thirty-three feet from No. 4 down to No. 3 in that boring, while at Elmwood it is only ninety-eight.

On one of the branches of the north fork of the Kickapoo, on sec. 5, in Jubilee township, coal 6 outcrops in the bed and along the banks of the creek. The coal is very irregular in its development in this vicinity, sometimes thinning out to a mere streak, and then thickening to five or six feet. No. 7 was also found here, represented at the outcrop by about a foot in thickness of rotten coal. About twenty feet or more above No. 7 we saw a bed of hard, brownish-gray limestone, some three or four feet in thickness, traversed by thin veins of calcite, and resembling somewhat the band of sparry limestone at the top of the Kingston section.

One mile and a half north-east of Princeville No. 7 is worked on a small branch of Spoon river. The coal varies in thickness here from two and a half to three feet, with a tolerable good roof of bituminous shale. No. 6 has also been found on this branch, and a shallow shaft sunk to it; but it proved so irregular in its development that the working of it has been abandoned, and all the coal mined at the time we visited this locality was obtained from No. 7, and it is probably the only coal that outcrops in the northern tier of townships in this county, except, perhaps, on Spoon river, in the north-western corner of the county, where No. 6 probably again appears above the river level.

Three miles north-east of Princeville a bed of limestone outcrops on the open prairie, and only from three to five feet below the general level of the surface. At Chase's quarries the bed is about twenty feet thick, the lower six feet being a true crinoidal limestone, composed almost entirely of the joints of small crinoids, and containing also a few fossil shells, among which we observed *Spirifer cameratus*, *Athyris subtilita*, *Hemipronites crassa*, and some remains of fishes. The middle and upper portion of the bed is nearly destitute of fossils, and is a thin-bedded, buff-colored, earthy limestone, a portion of which is in thin even layers from two to six inches thick, and is easily quarried in large slabs suitable for flagging. It is extensively quarried and used throughout the neighborhood for foundation walls, for walling wells, and for various other purposes for which a building stone is required. The middle portion of the bed has an earthy texture, and resembles a hydraulic limestone. The quarry can be cheaply worked, from the small amount of stripping required to clear the rock from the overlaying drift clays.

A few feet of blue clay shales were seen below the limestone, but no outcrop was found where a good section from coal No. 7 up to the limestone could be made. The nearest outcrop of the coal was about a mile and a half distant, and at a somewhat lower level, and I estimated the distance between them at about fifty feet. This would bring the limestone here about on the same stratigraphical level with that at Lonsdale's quarries on the south side of the Kickapoo; and although the limestone at Chase's quarries differs somewhat in its lithological characters from that at Lonsdale's, I am still disposed to regard them as probably equivalent beds. The distance between the limestone and the coal at Lonsdale's was forty-eight to fifty feet by measurement, while at Chase's quarries, according to the best estimate I could make, it seemed to be about the same. Furthermore, if this limestone represents a higher bed, then the Lonsdale limestone should be found outcropping between it and the coal, and from the thinness of the drift clays in this vicinity its outcrop could hardly be concealed. The color of the rock is very similar at the two localities, and there is also a general similarity between them, in this: that the purest limestone and the thickest layers are at the bottom of the bed, and the thinner impure layers above. But the lower part of the bed at Lonsdale's is a fine-grained, compact rock, while here the same portion of the bed is a rather coarsely granular crinoidal limestone, and the upper part of the bed at the one locality is in nodular, uneven layers, and weathers on exposure to a heap of limestone pebbles, while at the other it is more evenly-bedded, and can be quarried in slabs of considerable size. If these two exposures are not equivalent beds, then the Lonsdale limestone is not developed here at all, and the limestone north of Princeville is deposited unconformably upon the shales above coal No. 7. This limestone is the uppermost bed of rocks exposed in this part of the county, and its outcrop is on an elevated prairie, apparently one of the highest in this vicinity.

In tracing the various outcrops of the strata in this county the dip is found to be very slightly to the north eastward, and about three feet to the mile. Hence No. 6 coal, which, on the lower course of the Kickapoo ranges from seventy-five to eighty feet above the level of that stream, is found just below the level of the small creeks north of the Snatchwine, while No. 4 is from sixty five to seventy feet below their beds, and

No. 7 is the only seam outcropping above the level of the streams, and it attains here a thickness of about three feet, which is fully double what it will average in the southern part of the county.

Below the level of the Illinois river there is also at least two coal seams, as has been demonstrated by the borings of Voris & Co., opposite Peoria, and by the Elmwood Mining and Manufacturing Company, that are of sufficient thickness to be worked successfully whenever the supply from the higher seams becomes exhausted, making in all five seams underlaying nearly the whole of this county, except the valleys of the Kickapoo and the Illinois river.

Economical Geology.

Coal.—There are but few counties in the State where so great an amount of coal can be obtained at a minimum cost of mining as in this. Coals No. 4, 6 and 7 outcrop on all the streams in the southern part of the county, and can be worked in the most economical way by horizontal tunnels driven into the hill sides on the natural outcrop of the seams, while in the central and northern portions of the county, where the two principal seams are below the level of the creek valleys, they may be reached by shafts not exceeding seventy-five to one hundred feet in depth. These three coals have an aggregate thickness of about ten feet, and will yield ten million tons of coal to the square mile. They probably underlie fully one-half of the entire area of the county; and in addition to these there are probably two more, with an aggregate thickness of about seven feet, underlaying the whole area of the county, and capable of yielding about seven million tons of coal to the square mile. I know of no other county in the State, except Fulton, where so great an amount of coal can be mined at the same cost as here, and the facilities for transportation over the various railroads centering at Peoria, as well as by the Illinois river, are such as to make this one of the most important coal producing sections of the State.

The quality of the coal obtained from the three seams now being worked in this county is variable, and even from the same seam the quality varies somewhat at different localities. Most of the coal now mined in the southern part of the county, and on the lower course of the Kickapoo, is from No. 4, and the coal it affords is somewhat harder than that from either of the other seams, and therefore a better coal for transportation. The coal from No. 6 is not only softer, but freer from pyrite and other impurities, and is an excellent coal for the smith's forge. No. 7 also affords a soft coal, generally free from pyrite, but containing a much larger per cent. of ashes than that from No. 6. The following analysis, by Messrs. BLANEY and MARINER, of coals from this county is extracted from Dr. BLANEY'S Chemical Report, in Vol. I, page 276. The specimens were collected in 1858 from mines worked at that time, and the owner's name was given instead of the locality where the mines were located. The two first are an average of three analyses of specimens from different parts of the seam at one locality, and the last the result of only a single analysis:

Aiken's Mine—(Coal No. 4.)

Specific gravity	1.3122
Total volatile matters	36.9
Coke	63.1
	100.0

ANALYSIS:

Moisture	10.3
Volatile combustible matters	29.9
Carbon in coke	54.4
Ashes	8.7
	103.3

R. Howard's Mine—(No. 6.)

Specific gravity	1.2571
Total volatile maters	38.3
Coke	61.7
	100.0

ANALYSIS:

Moisture	11.2
Volatile combustible matters	27.1
Carbon in coke	59.5
Ashes	2.2
	100.0

Specimen from Isaac Brown's land—(Seam No. 7.)

Specific gravity	1.3228
Total volatile matters	37.2
Coke	62.8
	100.0

ANALYSIS:

Moisture	12.0
Volatile combustible matters	25.2
Carbon in coke	53.2
Ashes	9.6
	100.0

These analyses show that No. 6 contains the largest amount of fixed carbon, and the smallest amount of ashes, while the specimen from No. 7 contained a smaller per cent. of carbon and more ashes than either of the others. However, the actual value of this coal cannot be fairly judged from the result of a single analysis. At least three-quarters of all the coal mined in the county at the present time is taken from No. 4, and the others are only worked in neighborhoods where No. 4 is below the surface, except at some few points where No. 6 is mined in a small way for smith's coal. No. 6 is more irregular in its development than either of the others, and for this reason it is generally neglected. When fully developed it is quite as thick as No. 4, but the miner who commences drifting into this coal on a promising outcrop from four to five feet in thickness, will frequently, in the distance of a hundred yards or less, find the coal gradually thinning out to one-half or less its original thickness, and he becomes discouraged at the prospect and abandons the mine. But with a good slate and limestone roof, this seam may be profitably worked with an average thickness of no more than two and a half to three feet of coal, especially where it can be done by tunneling into the hill sides along its line of outcrop.

No. 4 is also more or less subject to the interruptions commonly known as "horsebacks," but they are seldom of any considerable extent ,and offer no serious impediment to the miner. Outcropping just above the level of the T., P. and W. Railroad, and also the Peoria branch of the C., B. and Q. Railroad, in the valley of the Kickapoo, it offers the best facilities possible for obtaining a fair quality and an abundant supply of coal at the lowest cost to those roads, for the supply of the less favored regions on the western borders of the State; and the amount of coal now annually transported from these mines is very large, and is constantly increasing. At the Orchard, Kingston, Lancaster and Liverpool mines, located in the western bluff of the Illinois river, large quantities of coal are annually taken out for the supply of steamers, and for transportation by the river to points below.

In the northern portion of the county, No. 7 is the principal coal outcropping above the valleys of the streams, and the lower seams can only be reached by shafts, or by an inclined tunnel carried down to their level. This seam ranges from two and a half to three feet in thickness in this part of the county, and its outcrop may be found on most of the small streams. It is very regular in its development, and affords a coal of fair quality where it is mined beyond the influence of atmospheric agencies.

Building Stone.—Sandstone of good quality may be obtained from the bed overlaying coal No. 4, which at some points on the Kickapoo is fully twenty feet in thickness, and it outcrops at many points under very favorable conditions for quarrying. The rock is a brown micaceous, and partly ferruginous sandstone, in massive beds, some of which are two feet or more in thickness. It presents a bold escarpment at many points where it outcrops, indicating a capacity for withstanding well the ordinary influences of the atmosphere. The ferruginous layers harden very much on exposure, and would form the best material for bridge abutments, and for all other purposes where a rock was required to withstand well the influences of frost and moisture.

On Aiken and Griswold's land, on the south side of the Kickapoo, on section 24, this sandstone has been somewhat extensively quarried, and the bed presents a perpendicular face of solid sandstone fully twenty feet in thickness. It is rather soft when freshly quarried and can be easily dressed, and splits freely into blocks suitable for building and for foundations walls. These quarries are located just above the level of the railroad grade, and are very conveniently situated for the transportation of the stone by railroad to the city of Peoria, or wherever else it might be in demand.

At Lonsdale's quarries, on section 14, T. 8 N., R. 7 E., the lower part of the limestone affords a durable building stone, though the layers are not usually more than from four to six inches thick. This rock is in common use in this part of the county for foundation walls, and there are several small buildings in this neighborhood constructed with this material. That portion of the bed which affords a building stone is from four to six feet in thickness.

At Chase's quarries, three miles north-east of Princeville, the limestone is nearly twenty feet in thickness, and though for the most part thin-bedded, yet the greater portion of it can be used for foundation walls, flagging, etc., and is the only building stone available in that portion of the county. The thickest layers are at the bottom of the bed here, as well as at Lonsdale's, but the middle and upper portion is more evenly bedded at this point, and may be quarried in thin even slabs of large size.

The limestone over coal No. 6 may answer for rough foundation walls where it can be protected from the atmosphere, but is generally too argillaceous to make a good building stone.

Iron Ore.—Concretionary bands of iron ore occur in the shales overlaying coals No. 4 and 7, but not in sufficient quantity to be of any economical importance. In the south part of the county, large concretions of iron and clay, the former mostly in the form of the bi-sulphuret, are quite abundant in the roof shales of No. 4 coal. Some of these concretions are two feet or more in diameter.

Clays.—We found no beds of fire or potters' clays in connection with the coal seams in this county, that appeared to be sufficiently free from foreign matters to be of much value, but excellent brick clays are abundant, the subsoil clays over a large portion of the uplands throughout the county being used for this purpose, and furnishing an abundant supply of brick of good quality at a moderate cost. The best beds of fire and potters' clays known at the present time in this State, are associated with coal No. 1, of our general section of the Illinois Valley coals, given on page 5, of Volume III of these reports; and should a shaft be sunk to that horizon in this county, good clays may probably be found here, and mined successfully in connection with these lower coals.

Sand.—The modified drift deposits, forming the terrace upon which the city of Peoria is mainly built, will furnish an inexhaustible supply of sand of various qualities, adapted to the varied economical uses to which this material is applicable, and it will also afford an excellent moulders' sand, in quantities sufficient for the supply of all the adjacent region.

Gravel.—An inexhaustible supply of clean gravel may be obtained from the gravel beds forming the bluffs at Peoria, and along the north side of the Kickapoo for a distance of eight or ten miles above the outlet of that stream. All the railroads in the State might obtain here an ample supply of ballast for their road beds, without greatly diminishing the amount of this material to be found in this county.

Timber.—There is an ample supply of timber in this county, the proportion of timber and prairie land being originally about the same. The timbered land is mostly confined to the ridges and valleys of the streams, though occasionally fine groves are met with on the level land adjacent to the prairie. The growth upon the upland is mostly black and white oak, pig-nut and shell-bark hickory, elm, linden, wild cherry, honey locust, wild plum and crab-apple; while on the bottom lands and the slopes of the hills, we find white and sugar maple, black and white walnut, pecan, cottonwood, sycamore, ash, red birch, coffee-nut, hackberry, mockernut hickory, post, Spanish and swamp white oak, red bud, dogwood, persimmon, mulberry, service berry, buckthorn, three or four varieties of willow and box alder.

Soil and Agriculture.—As an agricultural region this county ranks among the best in this portion of the State. The western and northern portions of the county are mostly prairie, and generally level or gently rolling. The soil is a dark chocolate-colored loam, rich in organic matters, and producing abundant crops annually of corn, wheat, rye, oats and barley, and, with judicious cultivation, this kind of soil will retain its fertility for an indefinite period of years, without the application of artificial stimulants. On the more broken lands adjacent to the streams, the soil is of a lighter color, but where it is predicated upon the marly beds of the loess, it is still productive, and scarcely inferior to the best prairie soils. Where the soil overlies the yellow drift-clays, the timber is mostly white oak and hickory; the soil is thin, and would be greatly improved by an annual application of manure liberally applied. These lands, however, produce fine crops of wheat and oats, and are excellent for fruit orchards and vineyards. The soil on the terrace and bottom lands is a sandy loam, and generally very productive.

In closing my report on this county, I desire to express my obligations to many of its citizens for their earnest co-operation and manifest interest in the work of the survey, and especially to Mr. MARK AIKEN, Dr. CHAPMAN, SIDNEY PULSIFER and WM. GIFFORD, Esqrs., for much valuable information and assistance, and to E. G. JOHNSON and family, for the enjoyment of a quiet home while at work in the county. The State Cabinet is also indebted to WM. GIFFORD, Esq., for several interesting fossils, collected by himself from the Coal Measures of this county, and to Capt. SMITH for a tooth and part of the jaw-bone of a mammoth, found by him in the modified drift of the Peoria bluffs.

CHAPTER XV.

McDONOUGH COUNTY.

This county is bounded on the north by Warren and Henderson counties, on the east by Fulton, on the south by Schuyler, and on the west by Hancock. It contains a superficial area of sixteen townships, or about five hundred and seventy-six square miles. The face of the country is generally level or gently rolling, except in the immediate vicinity of the streams, and consists of broad prairies covering the most elevated portions of the county, with belts of timber along the valleys of the streams and the broken land adjacent thereto. The prairies have a general elevation of seventy-five or a hundred feet above the valleys of the streams, and the soil upon them is a dark-chocolate colored, sandy loam, similar in general character to the prairie soils of the adjoining counties, and is admirably adapted to the growth of the cereals usually cultivated in this climate.

Timber is not as abundant in this county as in those adjoining it on the east and south, and covers less than one-third of its entire area. The principal varieties observed here were white, red, post, pin, black and Spanish oak, shell bark and pig nut hickory, red and slippery elm, linden, buckeye, white and sugar maple, cottonwood, sycamore, red birch, hackberry, white and red ash, honey locust, wild plum, crab apple, sassafras, red bud and dogwood.

The principal streams in this county are Crooked creek and its tributaries. The east fork of this stream traverses the county from north-east to south-west, while the main creek intersects diagonally only the south-western township. In the early settlement of the State several water mills were erected on this creek, and the inhabitants of this and the adjoining counties were largely dependent for many years on the water power it afforded for their milling facilities; but as the country was improved, and a considerable portion of its surface brought under cultivation, the supply of water gradually diminished from year to year, until many of the old mill sites have been abandoned, or else have added steam power to supply the lack of water during the dry season.

Geology.

The geological formations appearing at the surface in this county comprise the Quaternary, including the loess and drift; the lower portion of the Coal Measures, including the three lowest seams of coal; and the St. Louis and Keokuk divisions of the Lower Carboniferous limestones.

The entire area of the county, except the valleys of the streams, is covered with beds of Quaternary age, ranging from thirty to a hundred feet or more in thickness, and presenting the same general features that have been given as characteristic of this formation in the reports on the adjoining counties. Good natural exposures of these beds are but rarely found here, and the observer is compelled to rely mainly on such information as can be obtained from the well diggers, or others engaged in surface excavations, as to their thickness and general character. In the railroad cut on the north bank of Crooked creek, just below Colmar, the following section of Quaternary beds was seen :

Soil	1 to 2	feet.
Ash colored, marly clay (loess)	8 to 10	"
Reddish-brown clay	5	"
Sand and gravel, partially stratified	15 to 20	"

This exposure is considerably below the general level of the prairie, and the beds seem to have been subjected to some sifting process since its original deposition, giving to it the general characteristics of "modified drift." In the shafts of Colchester the drift clays generally range from thirty-five to forty feet in thickness, and consist of buff or brown clays, with gravel and boulders, passing downward at some points into blue clays, or "hard pan." Boulders of metamorphic rocks, of various kinds, and of all sizes up to a diameter of two or three feet, are scattered in considerable numbers in all the gulches and streams that cut through the drift beds, and are most abundant in the lower part of the drift deposits. No indication of the presence of an ancient soil, underneath either the loess or the drift, was seen at any of the points visited in this county; nor did we learn that it had been observed by any one else. The wells are seldom sunk to the bottom of the drift, and hence afford no indications of what may underlie the boulder clays in this county.

At Bushnell a boring for coal passed through 112 feet of these Quaternary deposits before reaching the bed rock, in the following order :

No. 1.	Soil	2	feet.
No. 2.	Yellow clay	12	"
No. 3.	Sand	2	"
No. 4.	Blue boulder clay	61	"
No. 5.	Blue and yellow sand	35	"
		112	

This is probably twice as much as the average thickness of these deposits in this county—the drill having evidently penetrated an old valley, where from sixty to seventy feet of Coal Measure strata had been removed by erosion, and the valley thus formed subsequently filled with the transported material. The average thickness of the drift deposits in this county probably does not exceed fifty feet.

Coal Measures.—All the uplands in the county are underlaid by the Coal Measures except a limited area on Crooked creek, in the south-western corner of the county, embracing nearly the whole of township 4 north, range 4 west, and the south-western portion of township 5 north, range 4 west. The beds composing the lower portion of the the Coal Measures, as they are developed in this county, give the following section:

No. 1.	Sandstones and sandy shales, partly ferruginous	20 to 30	feet,
No. 2.	Band of calcareous shale, with lenticular masses of dark-blue limestone, containing *Cardiomorpha Missouriensis*	2 to 3	"
No. 3.	Coal No. 3	2 to 3	"
No. 4.	Sandy shales and soft sandstone	35 to 40	"
No. 5.	Bluish clay shale, filled with fossil ferns	½ to 2	"
No. 6.	Coal No. 2	2 to 2½	"
No. 7.	Bituminous fire clay	2	"
No. 8.	Gray clay shale	6	"
No. 9.	Septaria limestone	3	"
No. 10.	Variegated shales, purple, yellow and blue	18 to 20	"
No. 11.	Sandstone, passing locally into shale	10 to 15	"
No. 12.	Coal No. 1, sometimes replaced with slate or blue shale	1 to 3	"
No. 13.	Fire clay, sometimes replaced by a sandy shale	2 to 3	"
No. 14.	Quartzose sandstone, (conglomerate)	5 to 20	"

These beds have a maximum thickness of about 150 feet, and consequently a boring anywhere in the county, carried down to the depth of two hundred feet from the surface, would pass entirely through the Coal Measures, and determine the amount of coal that could be found at that point. No coal seam is worked at the present time, except No. 2, or the Colchester coal; and it seemed to us quite probable that neither 1 nor 3 is developed in this county so as to be of any value to the industrial interests of its people. In the vicinity of Colchester the limestone and calcareous shale usually found above coal No. 3 outcrops in the breaks of the ravines west of the town, but no indications of the presence of the coal was seen. The concretionary or lenticular masses of dark-blue limestone were found quite abundant here, and they afforded *Cardiomorpha Missouriensis* in great numbers, associated with *Discina nitida*, *Productus muricatus*, *P. Prattenianus*, *Pleurotomaria sphærulata*, *Aviculopecten rectalaterarea*, two or three species of small *Goniatites*, fossil wood, and the spine of a fish *(Listracanthus hystrix)*. We also obtained from one of these limestone concretions, associated with the fossil wood above mentioned, a fossil fruit, shaped somewhat like an elongated pecan nut, the relations of which have not yet been determined. These limestone concretions have been found in Fulton and Schuyler counties overlaying coal No. 3, and affording most of the species of fossil shells obtained from it here; so that there seems scarcely a doubt but that it here represents the horizon of that coal. It is quite probable that in the eastern, and especially in the south-eastern portion of the county, coal No. 3 may be found sufficiently developed to be worked to advantage. The shale and sandstone above this coal, No. 1 of the foregoing section, we only saw in the vicinity of Colchester, where about ten feet in thickness of sandy, ferruginous shales overlay the limestone concretions above mentioned. No. 4 of the foregoing section is well exposed on the ravines leading into the east fork of Crooked creek, west of Colchester, but it is everywhere a sandy shale, with some thin layers of sandstone, but affords no material of any economical value. The calcareous shale associated with the limestone in No. 2 of the above section is, at some points near Colchester, quite full of small fossil shells, among which the *Spirifer plano-convexus* was the most abundant, associated with *S. lineatus*, *Chonetes mesoloba*, *Productus muricatus*, *Pleurotomaria Grayvillensis*, a small *Macrocheilus*, and fragments of a *Nautilus*.

No. 5 of the above section forms the roof of the Colchester coal, and is a true clay shale at the bottom, and locally quite bituminous, becoming sandy higher up, and gradually passes into the sandy shales of No. 4. It contains ironstone concretions similar to those at Mazon creek and Murphysboro, though usually not so perfectly formed, and they contain fossil ferns of the same species found at those localities. The shales also are filled with beautiful ferns, in a remarkably fine state of preservation; and this locality may be reckoned as one among the best in the State for collecting these beautiful relics of an ancient vegetable world. Two specimens of fossil insects and two or three species of shells have been found associated with the fossil ferns at this locality. The following list comprises all the species of fossil plants that have been identified at Colchester to the present time: *Neuropteris hirsuta*, *N. tenuifolia*, *N. rarinervis*, *Alethopteris aquilina*, *Callipteris Sullivantii*, *Pecopteris squamosa*, *P. villosa*, *P. unita*, *P. plumosa*, *P. chærophylloides*, *Sphenopteris irregularis*, *S. trifoliata*, *Hymenophyllites alatus*, *H. spinosus*, *H. splendens*, *H. Gutbierianus*, *H. thallyformis*, *Cordaites borassifolia*, *C. angustifolia*, *Sphenophyllum Schlotheimii*, *S. emarginatum*, *S. cornutum*, *Annularia longifolia*, *A. sphenophylloides*, *Asterophyllites equisetiformis*, *Calamites ramosus*, *C. approximatus*, *C. undulatus*, *Selaginites uncinnatus*, *S. cavifolius*, *Lepidodendron diplotegioides*, *L. simplex*, *L. obovatum*, *L. gracile*, *Ulodendron majus*, *U. ellipticum*, *Lepidophloios obcordatum*, *Lepidostrobus princeps*, *Lepidophyllum auriculatum*, *Sigillaria*

monostigma, *Stigmaria ficoides*, *S. umbonata*, *Pinnularia capillacea*, *Caulopteris obtecta*, *C. acantophora*, *Carpolithes multi-striatus*. Owing to the thinness of the coal, the roof shales are removed in driving the entries to the mines, thus affording a fine opportunity for collecting the many beautiful fossil plants that they contain. The thickness of the the coal at this locality varies from twenty-four to thirty inches, and at the level of the prairie it lies from seventy-five to ninety feet below the surface. On all the branches west of Colchester the coal outcrops, and is worked by tunneling into the hillsides. The city of Quincy, as well as most of the small towns along the Chicago, Burlington and Quincy railroad south of Bushnell, have for many years derived their supplies of coal mainly from the Colchester mines.

In the vicinity of Macomb the Colchester coal seam has not yet been found of sufficient thickness to be worked. About a mile and a half south-west of the town, a thin coal outcrops above the sandstone quarries of Mr Stewart, which I am inclined to regard as the Colchester seam, though it is here only about one foot in thickness. This may however be an outcrop of the lower seam No. 1, but from the appearance of the sandstone I believe it to be No. 2, thinned out here to about one-half its usual thickness. In the vicinity of Colchester a very good sandstone is found below the coal and from ten to fifteen feet in thickness. It is No. 11 of the foregoing section. This I believe to be the equivalent of the sandstone at Stewart's, and the old McLean quarries near Macomb. A section of the beds exposed in the vicinity of these quarries shows the following succession of strata:

Thin coal	1	foot.
Shaly clay	2	"
Thin bedded sandstone	1 to 6	"
Massive sandstone	10 to 12	"
Bituminous shale (coal No. 1 ?)	4	"
Carbonate of iron	½	"
Fire-clay	½	"
Bituminous slate or shales	⅔	"
Shale	5	"

The horizon of coal No. 1 is here occupied by bituminous shales and a six inch band of carbonate of iron. In the vicinity of Colchester, at most of the outcrops we examined, the same horizon was represented by dark-blue shales (No. 12 of the section previously given), containing nodules of iron ore inclosing crystals of zinc blende. On the south-west quarter of section 24, town 5 north, range 4 west, the following beds were found exposed in connection with coal No. 1:

Shaly sandstone	4	feet.
Coal No. 1	2	"
Fire-clay	not exposed	
Shaly sandstone	16	"
St. Louis limestone	6	"

Although we did not find this lower coal developed at any of the exposures examined in the vicinity of Colchester, yet it was found by Mr. Horrocks at his tile and fire-brick kiln, not more than a mile from the town, and was struck in one of the pits sunk for fire-clay. It was found to be about a foot in thickness only, and was associated with an excellent fire-clay, and was here about 45 feet below coal No. 2. Below Horrock's brick and tile kilns on the same stream, a band of ferruginous sandstone, or rather a sandy iron ore, was found, about six inches in thickness, filled with fossil shells, among which a large *Discina* was the most abundant, associated with *Hemipronites crenistria*, *Athyris subtilita*, *Spirifer opimus*, *S. Kentuckensis*, and some other undetermined species. This was no doubt a local deposit, and probably represents the band of iron ore occurring in Schuyler and Fulton counties, associated with coal No. 1. This band of iron ore occurs just at the junction of beds numbered 13 and 14 of the general section of the coal-bearing strata, on a preceding page.

On section 24, town 5 north, range 4 west, south-west quarter of the section, a coal seam was opened as early as 1853, when we first visited this county, on land then owned by Mr Lowry. The coal was from eighteen inches to two feet in thickness, overlaid by a few feet of shaly sandstone. Below the bed of coal there was about sixteen feet of sandstone exposed, and a short distance up the creek the concretionary limestone is exposed underlaying the sandstone. This I have no doubt is the lower coal (No. 1,) and it will no doubt be found at many points in the county ranging from one to three feet in thickness.

At this time coal was also dug on Mr. Thompson's place on the north-east quarter of section 16, town 4 north, range 3 west. The seam at this point was thirty inches thick, but was only exposed in the bed of the creek, with no outcrop of the associated beds. This is also, without doubt, the lower seam, as the concretionary member of the St. Louis limestone was found outcropping on the creek a short distance below where the coal was found. On the north-west quarter of section 33, town 4 north, range 3 west, a coal seam was opened and worked in 1853 on lands then owned by Mr. J. Stoneking. The coal was worked by "stripping" in the bed of a small creek, and the coal ranged from eighteen to twenty inches in thickness and was overlaid by about two feet of gray shale.

These two lower seams also outcrop on Job's creek, near Blandensville, and have been worked from the first settlement of the county. They outcrop also on nearly all the tributaries to the east fork of Crooked creek, and probably underlie at least seven-eighths of the entire area of the county. They seldom attain a thickness of three feet, however, in this portion of the State, but they are nowhere more than one hundred to one hundred and seventy-five feet below the surface at the general level of the prairie. No. 3, if developed anywhere in the county, will probably be found in the eastern range of townships, and would be the first seam reached in sinking a shaft or boring from the prairie level.

At Bushnell, a boring for coal at the steam mill passed through the following beds, as represented by those in charge of the work:

1.	Soil	2	feet.
2.	Yellow clay	12	"
3.	Sand	2	"
4.	Blue clay with boulders	61	"
5.	Blue and yellow sand	35	"
6.	Sandstone	5	"
7.	Clay shale	1½	"
8.	Black shale	½	"
9.	Gray shale	34	"
10.	Limestone	9	"
11.	Shale	1	"
		163	

The beds numbered 1 to 5 inclusive belong to the drift, and show an aggregate thickness of 112 feet, indicating the existence of an old valley here, in which the Coal Measures have been cut away down to a point below the horizon of the Colchester coal, and which was subsequently filled with drift deposits, and consequently that coal which should have been found at a depth of 50 to 70 feet below the surface at this point, was not met with at all. The limestone No. 10 of the above section is probably the bed overlaying the Seaville coal. The extent and direction of this old valley we have no data for determining at the present time, but it is probably a lateral arm of the Spoon river valley, and most probably trends south-eastwardly into the valley of that stream.

At Prairie City a boring was carried down to the depth of 222 feet, passing through the following beds, as reported by Mr. T. L. Magee:

1.	Soil and drift clays	36	feet.
2.	Clay shale or "soapstone."	16	"
3.	Black shale	½	"
4.	Coal No. 2	1½	"
5.	Fire-clay	4	"
6.	Shale and sandstone	12	"
7.	Clay shale	38	"
8.	Hard rock (limestone ?)	11	"
9.	Shale	4	"
10.	White flint	1	"
11.	Shale	10	"
12	Coal No. 1	3	"
13.	Fire-clay	6½	"
14.	Hard rock	5	"
15.	Clay shale	8	"
16.	Sandstone	4	"
17.	Dark-gray shale	8	"
18.	Clay shale (light colored)	14	"
19.	Limestone (St. Louis beds)	44½	"
		222	

In the foregoing section the beds numbered from 2 to 18 inclusive belong to the Coal Measures, and include the two lower coals. No. 19 is undoubtedly the St. Louis limestone which outcrops on Spoon river just below Seaville, about eight miles east of Prairie City. At Lawrence's mound, at an elevation considerably above the surface where the above boring was made, a coal seam three feet in thickness was found in digging a well, which was probably No. 3, occurring here as an outlier left by the denuding forces which swept it away from the surrounding region. It lay immediately below the drift, with no roof but gravel, and covered but a limited area of ground.

At Macomb, a boring, carried to the depth of about 160 feet, failed to find any coal of sufficient thickness to be of any economical value. From these experiments it would seem that the lower coals in this county are not very uniform in their development, and probably neither No. 1 nor No. 3 will be found over any considerable area thick enough to be worked to advantage, while No. 2 is also too thin to be worked at some points, though it may be considered the most persistent and reliable seam to be found in this county.

St. Louis Limestone.—This division of the Lower Carboniferous series is probably nowhere in this county more than fifty feet in thickness, and consists first, of a bed of light-gray concretionary or brecciated limestone, laying immediately below the lower sandstone of the Coal Measures; and secondly, of a magnesian limestone and some blue shales or calcareous sandstones, constituting what is sometimes called the "Warsaw limestones." On the east fork of Crooked creek, a little north of west from Colchester, the following section of these limestones may be seen:

No. 1.	Brecciated light-gray limestone	5 to 20 feet.
No. 2.	Calcareous sandstone in regular beds	12 "
No. 3.	Bluish shale	3 "

The magnesian bed, which usually forms the base of this group, is below the surface here, and generally ranges from eight to ten feet in thickness. The brecciated limestone is very unevenly developed, and often varies in thickness in a short distance from five to twenty feet or more. It rarely affords any fossils except the common corals *Lithostrotion canadense* and *L. proliferum*, silicious specimens of which are often found weathered out along the creeks where this limestone outcrops. No fossils were seen in the calcareous sandstone, but the magnesian limestone that outcrops lower down on the creek, and underlies the blue shale in the above section, usually contains a variety of *Bryozoans*, among which are the *Archimides Wortheni*, *Polypora Varsoviense*, *Semicoscinium Keyserlingi*, *etc.*

Keokuk Limestone.—This is the lowest rock exposed in the county, and is only found along the bluffs of Crooked creek, in townships 4 and 5 north, range 4 west. The upper part of this formation is usually a bluish calcareo-argillaceous shale, containing silicious geodes either filled with a mass of crystaline quartz, or hollow and lined within with quartz crystals, mammillary chalcedony, calcite and dolomite. Below this geode bed there is usually from thirty to forty feet of cherty gray limestone, the layers varying in thickness from a few inches to two feet or more, and separated by partings of shale. The limestone beds consist mainly of the remains of organic beings, the corals, crinoids and mollusca that swarmed in countless numbers in the primeval ocean, and the old quarries in this limestone afford a rich field for the student who desires to become fully acquainted with the varied and peculiar organic forms of this period. South of Colmar the grade of the C., B. and Q. railroad cuts into the upper part of this limestone to the depth of several feet, and from the material thrown out from this cut we obtained many specimens of the characteristic fossils of this limestone in an excellent state of preservation. The upper layers of the limestone had been freely exposed to the erosive action of the water during the drift period, and many of the silicious fossils were found completely weathered out from the shaly limestones, and in a most perfect state of preservation. Among the fossils found at this locality were many specimens of *Zaphrentis dalii*, *Spirifer Keokuk*, *S. lineatus*, *S. sub-orbicularis*, *Agaricocrinus Americanus*, *Actinocrinus bi-turbinatus*, *Cyathocrinus stellatus*, *Archimides Owenana*, *Hemipronites crenistria*, *Phillipsia Portlockii*, several species of fish teeth, etc. The lower portion of this limestone is usually below the level of the creek bottoms, but the upper portion is well exposed on the main creek in T. 4 N., R. 4 W., and on the east fork in T. 5 N., R. 4 W. In the region south of Colmar the geodiferous shales and the St. Louis limestones have all been removed by denudation before the depost of the drift, and the boulder clays now rest directly upon the upper part of the Keokuk limestone. A complete section of all the limestones below the Coal Measures in this county would show the following order of succession and thickness:

Light-gray brecciated limestone	5 to 20 feet.
Calcareous sandstone	12 "
Magnesian limestone and shale	10 " 12 "
Geodiferous shales of the Keokuk beds	20 " 30 "
Light-gray cherty limestone	30 " 40 "

Economical Geology.

Coal.—As may be seen from a perusal of the foregoing pages, a large portion of this county is underlaid with coal, and although the seams that are found here are much thinner than some of those that outcrop in Schuyler and Fulton counties, yet they have not only furnished an abundant supply of coal for home consumption, but for many years have furnished many thousands of tons annually for shipment south and west to the adjoining counties. The shipment from Colchester alone for the years 1866 and '67 was about 500,000 tons per annum, and the product of the mines has been constantly on the increase. The coal obtained here is of excellent quality if taken out at some distance from the outcrop, where it has not been exposed to atmospheric influences. The coal is tolerably hard, bright, and comparatively free from pyrite, and breaks freely into cubic blocks when mined. An analysis of this coal by Mr. HENRY PRATTEN, as reported in Dr. NORWOOD'S "Analyses of Illinois Coals," gave the following result:

Specific gravity	1.290	
Loss in coking		41.2
Total weight of coke		58.8
		100.0

ANALYSIS.

Moisture		5.4
Volatile matters		35.8
Carbon in coke		56.8
Ashes (light-gray)		2.0
		100.0
Carbon in coal	60.10	

This analysis shows this to be one of the best coals in the State, and its freedom from pyrite has always made it a favorite coal with the blacksmiths of this and the adjoining counties. The coal from the lower seam is usually harder than that from the Colchester seam, and less uniform in quality. Its thickness is also more variable, and frequently the coal is wanting altogether, and its place occupied by bituminous shales. Nevertheless, it sometimes attains a thickness of three feet, as at Seaville, in Fulton county, and the coal obtained there is of a fair quality. It is quite probable that this seam may be found in some of the eastern townships in this county, as thick as it is at Seaville, and if so, it might be worked to advantage, as its depth below the surface would probably nowhere exceed two hundred feet.

No. 3, if found at all in this county, would be met with in the uppermost layers of the bed rock, and immediately underneath the boulder clays, except at a few points, where it might be overlaid by a few feet of sandstone or sandy shale. It is less persistent in its development, however, than either of those below it, but its proper horizon may be readily recognized by the dark blue limestone and bituminous shales that are nearly always present, even when there is no development of the coal itself.

A boring carried down to the depth of two hundred feet would probably pass entirely through the Coal Measures in any portion of the county, and in the western part the subordinate limestones would be reached at a depth of one hundred and fifty feet or less. When the light-gray brecciated limestone of the St. Louis group is reached, it is useless to bore further in search of coal, and this limestone is so decidedly different in its appearance from any of the limestones in the lower part of the Coal Measures, that an expert would find no difficulty in identifying it, even by the smallest fragments taken up by the sand pump. Hence, it forms a reliable guide, both where it outcrops and where it may be reached by the drill, and determines the point below which no coal can be found.

Fire-clay.—The fire-clay under the Colchester coal has been used by Mr. Horrocks, at his kiln west of the town, for the manufacture of drain tile, fire-brick, etc., but recently he has obtained a better quality of fire-clay by sinking a shallow shaft down to the lower or No. 1 coal, which, at his kiln, is about forty-five feet below the Colchester seam. The horizon of this lower coal furnishes an excellent article of fire and potters' clay in various portions of the State, and it may, no doubt, be found at many points in this county, besides the one where it is at present worked.

Iron Ore.—There is a band of iron ore, very generally developed in connection with coal No. 1, and indications of its presence were observed at several points in this county, though not in sufficient quantity to justify an attempt to work it at the present time. On the creek below Horrock's brick kiln it is about six inches thick, but too sandy to be of much value, even if the quantity was greater. On the creek west of Macomb, a band of very pure iron ore occurs, about six inches thick, and it is quite probable it may be found somewhere in the county of sufficient thickness to be of some economical importance. In Schuyler county, there are two or three bands of ore associated with this same coal, attaining there an aggregate thickness of about two feet, and yielding on analysis about 52 per cent. of protoxide of iron. The ore is an argillaceous carbonate of iron, and compares favorably in quality with the best Pennsylvania ores.

On Mr. D. C. Flint's place, in Mound township, a deposit of bog iron ore of good quality is found, which is reported to be several feet in thickness, but the area covered by it has not been ascertained. Should it prove sufficiently extensive, and as pure as the sample sent to my office, it is a valuable deposit.

Building Stone.—The central and western portions of the county have an abundant supply of freestone from the sandstone bed intervening between coals No. 1 and 2. This is usually from ten to twelve feet in thickness, the upper part thin-bedded and quarrying out in thin, even slabs suitable for flags, while the lower part is quite massive, and splits evenly. At Stewart's quarries, two miles west of Macomb, there is about twelve feet in thickness exposed in the face of the quarry. The rock is a rather coarse-grained sandstone, nearly white in color, and furnishes a very durable material for foundation walls, and is also easily cut and may be advantageously used for all ordinary architectural purposes.

At these quarries the rock is very massive, but at the old McLean quarries, about half a mile to the westward of Stewart's, the sandstone is more regularly bedded, the layers varying from four to twelve inches or more in thickness. This sandstone is the equivalent of that on the T., P. and W. Railroad west of Seaville, in Fulton county, and is very similar in quality. Some of the beds seem to be sufficiently even textured for grindstones. The magnesian and arenaceous beds of the St. Louis group will afford the best material for culverts and bridge abutments that can be found in the State, as they are scarcely at all affected by the action of frost and moisture. The gray limestones of the Keokuk series make a durable building stone if protected from water, but split to fragments on exposure to ordinary atmospheric agencies. The brecciated limestone will make an excellent macadamizing material for the construction of turnpike roads, or for ballasting our railroads.

Limestone for Lime.—Good limestone for burning into quicklime may be obtained from the lower division of the Keokuk, and from the brecciated bed of the St. Louis group. Where the former is used, it should be selected with some care, as a portion of the beds contain too large a per cent. of argillaceous or silicious matter to slack readily when burned, and would yield only an inferior quality of lime. The light-gray, semi-crystalline layers are the best for this purpose, and will make a quick-lime of good quality. The brecciated limestone is, however, in many respects, the best rock in the county for this purpose, as it is usually a nearly pure carbonate of lime in its composition, and can be burned at less expense and makes a quicklime of superior quality. This limestone may be found on most of the tributaries of Crooked creek, and on the east fork as far north as the vicinity of Colchester.

Sand and Clay for Brick.—The subsoil, where it is predicated upon the marly beds of the loess, supplies these materials in nearly the right proportion for the brick yard; and when deficient in sand, this may be easily supplied either from the creek bottoms or sandy beds interstratified with the drift clays. These materials are so universally distributed that there is scarcely a neighborhood in the county where they may not be readily found at hand.

Soil and Agriculture.—There is not much variety in the general character of the soils in this county, and there is no considerable portion of its surface that will not bring good crops of the various cereals usually cultivated in this latitude, without other stimulants than those contained in the soil itself. The prairie soil is a dark, chocolate-colored loam, appearing nearly black when wet, and produces excellent crops of corn, wheat, oats, barley and grass, and where a proper rotation of crops has been the rule, no perceptible decrease in the annual product has been observed, even on lands that have been under constant cultivation for the last twenty-five or thirty years. The timbered lands are generally confined to the creek valleys, and broken ridges adjacent thereto. The soil on these timbered ridges is usually thin, but they are excellent fruit lands, and will produce fair crops of wheat, oats and clover, but they require manuring if subjected to long-continued cultivation. These thin soils are predicated upon the boulder clays, and the timber growth is mainly black and white oak, and hickory; and their uneven surface does not retain the vegetable and animal matters that are annually deposited upon them, but, on the contrary, these are swept away by the annual rains into the adjacent valleys, while on the level prairies they are retained, and add from year to year their fertilizing properties to the soil. The bottom lands on Crooked creek are very limited in extent, and are mostly subject to overflow. They afford some fine timber, the varieties of which have been enumerated on a preceding page.

CHAPTER XVI.

MONROE COUNTY.

The county of Monroe comprises an irregular-shaped triangular area on the south-western borders of the State, embracing about three hundred and eighty square miles. It is bounded on the north and east by St. Clair and Randolph counties and the Kaskaskia river, and on the south and west by Randolph county and the Mississippi river.

It presents considerable diversity of surface, the region adjacent to the river bluffs being quite hilly and broken, while the eastern portion of the county is comparatively level, and affords a considerable area of excellent farming lands. In that part of the county underlaid by the St. Louis limestone, comprising most of the central and south-western portions of the uplands, "sink-holes" are so numerous as to render the land nearly valuless for agricultural purposes. These "sink holes" are funnel-shaped depressions in the drift clays overlaying the bed-rock, leading down to a crevice or cavern in the limestone below, through which the water that falls upon the surface finds an outlet into the adjacent streams. They are often fifty feet or more in depth, with an open crevice at the bottom leading into a yawning chasm or cavern beneath the surface. Occasionally the crevice at the bottom becomes filled up with the clayey sediment that washes into it, and small ponds of water are thus formed, some of which, in the vicinity of Waterloo, cover an area of several acres, and are filled with fish.

The principal streams in Monroe county are Fountain creek, which rises in the highlands south of Waterloo, and runs in a north-westerly course until it enters the American bottom, and from thence south-westerly, emptying into the Mississippi near Harrisonville; Horse creek, which intersects the southern portion of the county; and Prairie du Long creek, which waters the eastern portion, both emptying into the Kaskaskia river.

This county was originally heavily timbered, there being but three or four small prairies in its eastern portion, the largest of which are New Design prairie, Prairie du Long, and Prairie du Rond, none of which exceed an area of three or four square miles in extent. The timber upon the uplands consists mainly of the usual varieties of oak and hickory on the broken lands, with the addition of elm, black walnut, hackberry, wild cherry, honey locust and linden, on the more level portions in the eastern part of the county.

The western portion of the county, embracing nearly one-fourth of its entire area, is included in what is known as the "American Bottom," which extends along the eastern bank of the Mississippi river from Alton, in Madison county, to the mouth of the Kaskaskia in Randolph county, a distance of about eighty miles. The average width of this alluvial belt in this county is about four miles, and its extent from north-west to south-east something over thirty miles. These bottom lands are exceedingly fertile, and, except for their occasional overflow, would rank among the most valuable lands in the State. There are several fine lakes in this portion of the county, among which are Moredock, Kidd, and the Grand Coule lakes, with some others of less note. Some of these are fed mainly by subterranean streams, which find their way through the fissures and caverns of the limestones underlaying the adjacent highlands, and the water is quite clear, presenting a pleasing contrast to the turbid waters of the Mississippi. They are filled with fish, and are favorite resorts for the sportsman both for hunting and fishing. These bottom lands are for the most part heavily timbered with cottonwood, ash, elm, sycamore, black and white walnut, hackberry, linden, honey locust, pecan, persimmon, soft maple, water and Spanish oaks, hickory, wild cherry and coffee-nut.

Superficial Deposits.—The highlands in this county are covered with a variable thickness of drift clays and loess, usually ranging from ten to sixty feet, and at some few points near the river bluffs attaining a maximum thickness of seventy-five to one hundred feet. The loess is mostly restricted to the vicinity of the river bluffs, and often forms mound-like elevations on their summits of thirty to fifty feet in hight. It consists of a buff-colored, sandy loam, often filled with bleached fresh water and land shells, and is sufficiently coherent to retain its position in perpendicular walls on either side, when an artificial cut is made through it. It forms the bald, treeless knobs that constitute a conspicuous feature in the scenery of our principal western rivers. At Salt-lick Point the slope above the limestone measures 125 feet; but it is impossible to say whether the whole of this is formed by superficial deposits, or in part by a hidden nucleus of limestone; but it is quite probable that the drift clays and loess are here at least a hundred feet in thickness.

At Mr. Stumpf's place, on the S. W. qr. of Sec. 3, T. 2 S., R. 10 W., on sinking a well near his dwelling about thirty feet of yellow drift clay was passed through, below which was a black peaty soil with fragments of wood. This was underlaid by seven or eight feet of hard blue clay. This is the only place where a true soil under the drift clays was reported to me in this county; but it is quite probable the same thing occurs at other points, the interesting fact being overlooked, or not considered worthy of especial attention by those who have had an opportunity of observing it.

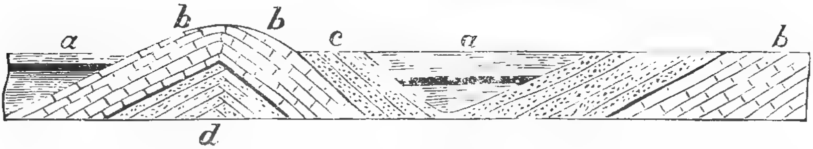
Good exposures of drift were met with along the bluffs of the small creek west of Columbia, where it seems to be fifty feet or more in thickness, and consists of buff or brown clay at the top, with bluish or purple beds at the bottom, the whole containing small pebbles of metamorphic rocks, and occasionally boulders of the same material of considerable size, but rarely more than two feet in diameter. Where the exposures occurred near the outcrop of the green and purple shales of the Chester group the lower beds of drift seemed to approximate closely to these shales in color, indicating the source from which they have, in part at least, been derived.

Stratified Rocks.

The paleozoic formations are largely represented in this county, including all the usual subdivisions of that age, from the lower Coal Measures to the middle of the Trenton limestone, except the Devonian and Upper Silurian, which are wanting at the only locality where they should appear, leaving a hiatus in the sequence of the strata, and allowing the shales and shaly limestones of the Lower Carboniferous series to rest directly upon Lower Silurian strata.

There are two decided axes of disturbance in this county, the most northerly of which intersects the Mississippi bluffs just over the line in St. Clair county, and about three miles north-west of Columbia, and extending thence about south 20 deg. east, passes a little to the eastward of that town, and to the westward of Waterloo, forming the high ridge on which the old stage road runs between these points. The nucleus of this axis is the Keokuk limestone, which may be seen well exposed on a small creek intersecting this axis about half a mile east of Columbia. There is about fifty feet of this limestone exposed here, the upper forty feet consisting of coarse, thin bedded, brownish-gray and cherty limestones, containing *Spirifer Keokuk*, *S. neglectus*, *and Archimedes Owenana*, while the lower ten feet of the exposure consists of blue calcareo-argillaceous shales, with small geodes of quartz, the whole probably representing the geodiferous beds of this group at more northern localities.

Immediately west of this outcrop the overlaying St. Louis limestone dips west 20 deg. south at an angle varying from 20 to 30 degs., while on the eastern side of the axis the dip in the opposite direction varies from 8 to 12 degs. This axis forms a synclinal trough or valley on its western side, extending from the river bluffs north-west of Columbia to the vicinity of Waterloo, with a varying width of from one to three miles, in which an outlier of coal has been deposited, hereafter to be described. The following wood-cut will give a general idea of the relative position of the beds in this part of the county and the relation of the Coal Measures to the underlaying limestones. The section represented by the cut crosses the beds from north to south, and extends from the Coal Measures in the edge of St. Clair county east of Columbia westwardly to the river bluffs, a distance of about three miles:



a, Coal Measures; *b*, St. Louis Limestone; *c*, Chester Group; *d*, Keokuk Group.

From an examination of this section it will be seen, that, at its northern extremity, the Coal Measures rest directly upon the St. Louis limestone, while in the synclinal basin the coal holds its normal position, overlaying, though unconformably, the Chester group. From these facts we may infer that the disturbance in the underlaying limestones took place anterior to the coal epoch, and that the beds on the northern slope of the axis were subjected to erosive agencies, by which the whole of the Chester group, including a thickness of at least one hundred and fifty or two hundred feet of strata, were entirely removed, so that the subsequently deposited Coal Measures rest directly upon the St. Louis limestone. Evidences of the powerful action of erosive agencies immediately antecedent to the coal epoch, have been observed in other portions of the State, but no locality has been noticed where so great a thickness of strata has been removed by such agencies as in this vicinity.

The other axis to which we have referred, crosses the Mississippi in the vicinity of Platin rock, in Missouri, where, according to the section of Dr. SHUMARD, given in Vol. I of the Missouri report, page 145, the St. Peter's sandstone (or Saccharoidal sandstone of that report,) is elevated above the river level, and there forms the nucleus of an anti-clinal axis, and although the dip and strike of the beds at that point are not given in the report above referred to, yet it seems quite probable that the elevation of the Trenton limestone above the surface at Salt-lick Point, in this county, is but a continuation of the same axis, which brings up the underlaying sandstone on the Missouri shore. This axis does not appear to extend very far to the eastward of the river bluffs in this county, and the Trenton limestone only appears along the base of the bluffs for a mile and a-half or two miles, when it sinks rapidly below the surface, and is replaced by the overlaying shales and limestones of the Lower Carboniferous series, the Devonian and Upper Silurian systems being both unrepresented at this point.

The following section will show the relative position and comparative thickness of the stratified rocks in this county :

No. 1.	Coal Measures.	40 to 50	feet
No. 2.	Chester group	100 to 350	"
No. 3.	Upper St. Louis limestone	140 to 150	"
No. 4.	Lower St. Louis or Warsaw beds	120 to 130	"
No. 5.	Keokuk limestone	150	"
No. 6.	Burlington limestone	75 to 100	"
No. 7	Kinderhook group	80 to 100	"
No. 8.	Trenton limestone (in part)	120	"

The aggregate thickness of these rocks may be estimated at about one thousand feet, and they represent a very large portion of the whole paleozoic series below the Coal Measures, as that series is developed in Southern Illinois.

Coal Measures.

An outlier from the main coal field, in St. Clair county, impinges on the county line immediately north of Columbia, and at some points probably extends a little over the line into this county, following very nearly the trend of the county line. The mines worked at this locality are known as Henckler's mines, being owned and worked by Mr. H. F. Henckler, of Columbia, and are located on sections 13 and 14, township 1 south, range 10 west, and are mostly in St. Clair county. The coal obtained here is a good block coal, and if on further examination it proves to be sufficiently uniform in its development to admit of successful mining, it will prove, from its proximity to the iron furnaces at south St. Louis, a valuable acquisition to the mineral resources of this portion of the State. The coal rests directly upon the St. Louis limestone, with only a few inches of dark colored clay shale between, and the coal seems to follow the inequalities of the limestone surface on which it rests, and at one point in the mine it was seen to rise abruptly to the hight of about six feet with the elevation of the limestone floor on which it rested, and as suddenly sink again to its former level. The main point to be determined is, whether these inequalities may not be so frequent, and sometimes so great, as to cut off the coal entirely, and thereby greatly increase the cost of mining. The seam is about three feet thick, when fully developed, and ranges usually from two to three feet in thickness. It is quite free from pyrite, and presents all the essential characters of a true block coal. It is overlaid by a few feet of argillaceous limestone, passing locally into calcareous shales, above which we found a stratum of soft porous limestone about two feet thick, that appeared as though it had been subjected to a process of leaching, by which a large portion of the calcareous matter had been removed, the stone now presenting the appearance of a soft porous chert. It contained numerous casts of fossil shells.

This coal has been struck at numerous points in this neighborhood in sinking wells, the general trend of the outcrop being to the south-east. At Mr. Snyder's place, on the south-east quarter, section 27, township 1 south, range 9 west, it outcrops in the bluffs of Prairie du Long creek, and has been worked in a small way for several years. The beds exposed here afford the following section:

No. 1.	Nodular argillaceous limestone	4 to 6	feet.	
No. 2.	Slope with partial outcrops of shale	15 to 20	"	
No. 3.	Compact bluish-gray limestone	3	"	
No. 4.	Gray shale	1	"	3 in
No. 5.	Argillaceous limestone	2	"	6 in
No. 6.	Bituminous shale	2	"	
No. 7.	Coal	3	"	
No. 8.	Shales, partly bituminous	2	"	
No. 9.	Argillaceous and sandy shales—exposed	15	"	

The lower shales, No. 9 of the above section, probably belong to the Chester group, and these, with some underlaying beds belonging to the same formation, are well exposed for some distance down the creek below the outcrop of the coal. The nodular argillaceous limestone, No. 1 of the above section, closely resembles the bed usually found underlaying the Belleville coal, in St. Clair and Madison counties, and contains a similar group of fossils, among which the *Bellerophon nodocarinatus* may be cited as especially characteristic of this horizon. This would seem to identify the coal at this point, and that at Heneckler's mines, with the lower seam at the old Pittburg mines in the bluffs east of St. Louis, and if more extensively explored in that vicinity, it might be found to possess the same characteristics which prevail in it on the southern borders of the county. Hitherto this seam has been almost entirely neglected, in St. Clair county, for the thicker seam laying immediately above it, but if it should prove, on further examination, that it retains its peculiar block character throughout the county, it would prove a valuable addition to the mineral resources of that county.

The principal deposit of coal in Monroe county is found in the long, narrow, synclinal basin already referred to, which extends from the river bluffs, just below the St. Clair county line, in a course of south 20 deg. east, to a point two and a half or three miles north-west of Waterloo, forming a narrow belt of coal lands, varying, as originally deposited, from one to three miles in width.

Gall's coal mines, on the north-west quarter of section 3, township 2 south, range 10 west, have been more extensively worked than any others in this isolated basin, though others have been opened at various points, and after being worked for a short time have been abandoned. The beds exposed in the vicinity of Gall's mines give the following section :

No. 1.	Calcareous shales	6 to 8 feet.
No. 2.	Compact argillaceous, dark-blue limestone	3 to 4 "
No. 3.	Bituminous shale	1 to 3 "
No. 4.	Coal (Belleville seam)	3 to 4 "
No. 5.	Calcareous shales and nodular limestone	3 to 4 "
No. 6.	Shale and shaly sandstone	15 "

The limestone and shales forming Nos. 1 and 2 of the above section closely resemble the beds usually overlaying the Belleville coal, in St. Clair county, and contain the same group of fossils, among which are *Spirifer cameratus*, *S. lineatus*, *Athyris subtilita*, *A. Royissii*, *Chonetes mesoloba*, *C. Smithii*, *Productus punctatus*, *P. costatus*, *P. Prattenianus*, *P. longispinus* and *Trachydoma nodosa*. Hence we have referred this coal to the horizon of the Belleville seam, although the seam is not so thick here as it is in St. Clair county, and the coal it affords is inferior in quality. We saw no indication of the development of the Henckler seam, in this vicinity, though it is not improbable that it may be found in some portion of this isolated basin. On the creek running through Mr. Gall's land we found continuous exposures from his coal, down to the Lower Carboniferous limestones, without any indications of the presence of any underlaying seam. A little to the eastward of Gall's old shaft the St. Louis limestone may be seen in heavy beds, dipping west 20 deg. south, at an angle of about 30 deg., overlaid by the Chester beds, dipping in the same direction and at a slightly decreased angle, while the beds of the Coal Measures lie nearly horizonal, and rest unconformably upon the subordinate limestones. On the western side of this synclinal the dip of the limestones is much less, varying from 6 to 10 deg. to the eastward.

Over some portion of this synclinal valley the coal has been swept away by denuding forces, and heavy beds of drift clay now occupy the place of the coal deposits; and it is not probable that any considerable area is now underlaid by coal of sufficient thickness to be profitably mined, in competition with the well developed coals of St. Clair county. However, the completion of the narrow-gauge railroad from St. Louis, south through this neighborhood, may afford a better market for coal than they have heretofore had, and should stimulate research to develop whatever fuel resources exist in the county.

Chester Group.—This upper group of the Lower Carboniferous system, as developed in this county, consists of a heavy bed of sandstone forming its lower division, above which there are two or three beds of limestone, alternating with sandstones and sandy and argillaceous shales; the whole series thinning out to the northward, and scarcely attaining to one-half the thickness in this county that they have in Randolph.

We found no exposures where accurate measurements of the whole group could be made, but its thickness may be estimated at from 250 to 300 feet in the southern part of the county, and at something less than 100 feet in the northern part. On sections 9 and 3, in township 2 south, range 10 west, we saw the following section above the top of the St. Louis limestone:

No. 1.	Brown, ferruginous sandstone	4 to 6 feet.
No. 2.	Green and purple shales, with plates of limestone	6 "
No. 3.	Gray limestone	5 "
No. 4.	Ferruginous sandstone	3 "
No. 5.	Green, blue and yellow shales	15 to 20 "
No. 6.	Ferruginous sandstone and shale	40 to 50 "
No. 7.	St. Louis limestone	partially exposed.

At this locality the gray limestone, No. 3 of the above section, as well as the plates of limestone intercalated in the shales above it, are filled with the characteristic fossils of this group, among which were *Pentremites godoni*, *P. pyriformis*, *Athyris ambigua*, *A. Royissii*, *Spirifer Leidyi*, *Productus elegans*, *Archimedes Swallovana*, and numerous plates of *Agassizocrinus*. Between the sandstone at the base of the foregoing section and the underlaying St. Louis limestone there is about three feet of green and purple shales, with a thin ledge of lime conglomerate intercalated in it. The beds at this point all have a decided dip to the eastward.

On section 16, township 3 south, range 9 west, about five miles south-east of Waterloo, the lower limestone of the Chester group is partially exposed, on Mr. H. Druse's place, where about six feet of thin-bedded, brownish-gray limestone was found, underlaid by three or four feet of blue clay shale, which directly overlaid the lower sandstone of this group. About a mile north of Mr. Druse's place, on a branch of Prairie du Long creek, the upper portion of the St. Louis limestone is well exposed, forming a perpendicular cliff about twenty feet in hight. Following down the creek in an easterly direction for about half a mile, the dip of the beds carries the limestone beneath the surface, and it is immediately succeeded by the sandstone of the Chester series, which forms a perpendicular cliff for some distance along the creek, ranging from forty to fifty feet in hight.

On a branch of Stone creek, which heads a little to the north-eastward of Waterloo, the Chester sandstone is well exposed, the first outcrops appearing about a mile and a half from the town and continuing down the creek for a half mile or more, where about thirty feet in thickness of the sandstone may be seen in the bluffs of the stream. The rock is here partly massive and concretionary in structure, and partly thin-bedded, affording layers from two to four inches in thickness. Proceeding north-eastwardly from this sandstone outcrop to the main creek, where it is crossed by the road from Waterloo to Belleville, partial outcrops of the lower Chester limestone, and the overlaying shales, are seen on a branch of the creek, and on the main stream the second bed of limestone and the overlaying shales are well exposed, and are filled with the characteristic fossils of this group.

Three miles south of Freedom, at the crossing of Prairie du Long creek, the entire bluff is composed of Chester limestone and shales. This exposure is about fifty feet in thickness, consisting of coarse, granular and partly crinoidal limestones, with intercalated bands of shale, containing many of the characteristic fossils of this group. We obtained at this locality the following species in addition to those mentioned on a previous page, from about the same horizon: *Pentremites sulcatus*, *Zeacrinus maniformis* and *Z. Wortheni*. The best exposures of these limestones in this county may probably be found on this creek and its tributaries, and the entire thickness of the group in the south-eastern part of the county cannot be less than 250 feet.

These limestones and shales are also partially exposed on the western borders of the synclinal basin already referred to, but the exposures are mostly isolated, and no continuous section of the several divisions of the group can be seen, but fine localities for collecting the fossils of this horizon occur in this part of the county.

St. Louis Limestone.—This limestone occurs in extensive outcrops in the county, and in two well marked divisions. The upper division consists mainly of light-gray, compact, regularly bedded limestones, with some thin, shaly partings; and the lower, of buff or brown marly and partly magnesian beds, with some very massive layers of a semi-oolitic, nearly white limestone, which are well exposed about a mile east of Columbia, where they constitute the upper beds of this division. This group forms the main portion of the river bluffs from the center of township 1 south, range 10 west, to Eagle Cliff, below which the Keokuk and Burlington beds gradually rise above the surface, and cap the the hills in the vicinity of Salt Lick Point, near the south line of township 2 south, range 11 west. Below this point these limestones soon dip again below the surface, and the St. Louis group, with an occasional outcrop of the Keokuk beds, continue to form the main portion of the river bluffs to the south line of the county.

The upper division of this group forms the bed rock over a considerable portion of the county, and wherever this is the case the surface is covered with sink holes which form a sure guide to the extent of its outcrop. All of that portion of the county lying between Fountain creek, west of Waterloo, and the river bluffs, and extending thence in a belt from three to six miles in breadth, in a south-easterly direction, to the Randolph county line, is covered with sink holes, and for agricultural purposes may be regarded as the poorest lands in the county. There is also a limited area north-east of Waterloo, where this rock comes to their surface, and where sink holes are abundant, but the strong easterly dip of the strata soon carries it beneath the sandstones of the Chester group, which, with the overlaying limestones and shales, form the bed rock thence to the eastern line of the county.

About a mile east of Waterloo, the uppermost beds of this group are exposed at their junction with the overlaying sandstone. About ten feet in thickness of the limestone may be seen here, the lower three feet of which is a very hard shell breccia, largely composed of chambered shells belonging to the genera *Nautilus*, *Goniatites* and *Orthoceras*, and seems to be the exact equivalent of a similar bed occurring at Greencastle, Indiana, where the rock, though similar in character, is not so hard, and its characteristic fossils may be obtained much more easily, and in a better state of preservation. The beds above this brecciated limestone, contain *Lithostrotion proliferum*, *Zaphrentis spinulosa*, etc., and are immediately overlaid by the Chester sandstone.

One mile east of Columbia, extensive quarries are opened in the lower portion of the upper division of this limestone, both for a supply of building stone, and for lime burning. The rock is evenly bedded, the layers ranging from an inch to two feet in thickness, and abound in the characteristic fossils of this horizon, especially corals and bryozoans. These quarries show a perpendicular face of about fifteen feet. Quarries have also been opened in the upper portion of this division east of Waterloo, but they are mostly in the beds of the small streams, and show but a few feet in thickness of strata.

Two and a half miles west of Waterloo, on Fountain creek, the upper division of this limestone is well exposed, forming the entire bluffs of the creek for several miles. There is from 75 to 80 feet in thickness of strata exposed here, the lower portion of which is a light-gray, regularly-bedded limestone, similar in appearance to the beds quarried one mile east of Columbia. These are overlaid by from 30 to 40 feet of thin-bedded, semi-oolitic limestone, containing a peculiar group of small fossil shells, among which are *Straparollus similis*, *S. planus*, *Dentalium venustum*, *Nuculana curta*, *Yoldia? levistriata*, *Rhynchonella mutata*, *Terebratula hastata*, *Hemipronites crenistria*, (small variety,) and some other undetermined species. These beds are overlaid by about fifteen feet of light-gray, or nearly white oolite, in tolerably massive beds, which form the upper portion of the exposure at this locality. The lowest beds seen at this point contain some of the characteristic crinoids of this group, among which are *Poteriocrinus Missouriensis*, *Forbesiocrinus Shumardianus*, *Graphiocrinus dactylus*, and spines of *Archiocidaris Wortheni*. These crinoids are associated here with *Athyris ambigua*, *Spirifer Keo-*

kuk? Hemipronites crenistria, Productus scitulus, P. tenuicostatus, P. punctatus, Zaphrentes spinulosa, and numerous *Bryozoans.*

Four miles south-east of Waterloo, there are some old quarries known as the "Portland quarries," which are in an earthy, buff-colored magnesian limestone, of which only about six feet in thickness is exposed. This rock closely resembles the limestone used at the cement mills north of Columbia, in the edge of St. Clair county, and probably belongs to the same geological horizon, near the base of the Warsaw division of the St. Louis group. The rock exposed here has every appearance of a good hydraulic limestone, and will probably prove to be valuable for the manufacture of hydraulic lime. As no other beds were exposed in connection with this, its stratigraphical position is only inferred from the lithological resemblance of the rock to that used at the cement mill above referred to; but I have little doubt it will prove identical with that, as the exposure is nearly on the line of the anticlined axis already mentioned as extending from a little east of Columbia to Waterloo, and which must pass in its further extension very near to this locality.

The Warsaw division of the St. Louis group is well exposed in the vicinity of Columbia, where it outcrops on the hill sides east of the town, and quarries have been opened in it at several points. It consists of buff, brown and light-gray limestones, partly thin-bedded and marly and partly massive; the thin bedded layers being filled with *Bryozoans* and the small *Brachiopoda* peculiar to this horizon. The old quarries to the left of the Centerville road were partly opened in the marly layers of this rock, and the weathered debris afforded many fine specimens of its peculiar organic forms. We found the *Pentremites conoides* quite common, and were so fortunate as to find a single perfect specimen of *P. obliquatus* of Rœmer, a very rare species in this State. *Rhynchonella mutata* and *Orthis dubia* were also quite abundant at this locality. Mr. H. F. Henckler found, in one of these old quarries, a crushed specimen of *Melonites*, that closely resembles the *M. multipora* of the upper division of this group.

Above the beds from which these fossils were obtained there is about twenty feet in thickness of massive light-gray limestone, which stands exposure well in the quarry, is free from silicious matter, and splits evenly, and will afford an excellent building stone. This portion of the bed is nearly destitute of fossils, but from some earthy layers above it we obtained some fine specimens of *Productus ovatus.* In the river bluffs, these buff limestones outcrop in the vicinity of Eagle Cliff; also about a mile and a half below Salt Lick Point, where they form a bluff about one hundred and twenty five feet in hight, the whole of which consists of regular-bedded buff and light-gray limestones, that belong to this lower division of the St. Louis group; and from this point to the south line of the county, they are well exposed at many points in the river bluffs.

Keokuk group.—The outcrop of the upper portion of this group, where it forms the nucleus of the anticlinal axis passing a half mile east of Columbia, has already been mentioned, but good exposures are rare, and only a few feet in thickness of these beds are to be seen at the various localities examined along the trend of this axis. At Mr. Ditch's place, a half mile north of Waterloo, on the Columbia road, a well was sunk to the depth of about a hundred feet, the first 20 feet being drift clay, and the remainder through the shales and limestones of the Keokuk group. This is evidently near the center of the axis, as a mile and a half north-east of this point the hard gray limestones of the upper division of the St. Louis group outcrop at the surface, dipping eastwardly at an angle of about 5 deg. Two miles and a quarter north-west of Waterloo, on the road leading in the direction of Gall's coal bank, a yellow calcareous shale, with intercalated plates of chert and limestone, are found out-cropping on a small creek running to the westward into Fountain creek. This shale contained small quartz geodes, and the plates of limestone afforded specimens of *Archimedes Owenana*, *Spirifer lineatus*, *S. cuspidatus*, and some other organic forms of the Keokuk group.

One of the best exposures of this group seen in the examination of this county was found on Mr. Prior's place, about a mile and a half to the eastward of Salt Lick Point. The beds at this locality afforded the following section:

1.	Coarse grained gray limestone	25 to 30 feet.
2.	Yellow calcareous shales	12 "
3.	Slope, with partial outcrops of blue shale	35 "
4.	Cherty gray limestone	60 "
5.	Bedded chert	6 "
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The upper limestone in the above section is a good building stone, and contained the characteristic fossils of this horizon, among which we observed *Spirifer Keokuk*, *Productus magnus*, and *Terebratula hastata*. The bedded chert at the base of the section may possibly belong more properly to the Burlington, than to the Keokuk series.

In the river bluffs two miles west of Glasgow, the lower portion of the bluff consists of the shales and thin-bedded limestones of this group, of which a hundred feet or more in thickness is here exposed. These beds are full of fossils, among which *Spirifer Keokuk*, *S. cuspidatus*, *Productus magnus*, and *Chonetes plano-convexa*, are quite abundant, associated with several species of rare crinoids, among which are the *Onychocrinus Monroensis* and *Zeacrinus plano-brachiatus*, figured and described in the second volume of these reports, with several other as yet undetermined forms. The lithological character of the rock in this county is quite different from that presented by it at the outcrops along the Illinois river and the upper Mississippi, and two of the most common *Brachiopods* here, the *Productus magnus* and *Chonetes plano-convexa*, we have not met with in any exposures of this formation north of St. Louis. The crinoids also are, for the most part, specifically distinct from those most common at more northern localities, and seem to be more nearly allied in form to those occurring at Crawfordsville, Indiana. The shales forming Nos. 2 and 3 of the above section are most probably the stratigraphical equivalents of the geodiferous shales of the more northern localities, though we found no geodes in this county, except those of very small size, and these seldom well crystalized on their interior surfaces. If we are right in this conclusion, then the overlaying regularly-bedded limestone is a local deposit, which seems the more probable from its containing some fossils that are not known to occur at any locality north of this county, such as *Productus magnus*, and *Chonetes plano-convexa*. The fossils of these upper beds have a striking resemblance to those from Crawfordsville, Indiana.

Burlington Limestone.—This limestone is confined in its outcrop to the vicinity of Salt Lick Point, where it forms the upper escarpment of the bluff, and is also well exposed on some of the small streams that intersect the river bluffs in this vicinity. Its thickness here probably does not exceed seventy five feet, and it consists of alternations of light-gray crinoidal limestone and chert, the latter at some points predominating. A section of the beds forming the bluff at Salt Lick Point shows the following order of succession:

		Feet.
1.	Covered slope, apparently composed of loess	125
2.	Burlington limestone	70
3.	Ashen-gray shales and chocolate colored limestones	80 to 90
4.	Massive gray Trenton limestone	100 to 120

This is believed to be the highest bluff between St. Louis and Chester on the east side of the river, and the view from its summit is very fine. St. Louis is distinctly visible to the northward, and the valley of the Mississippi, for a distance of at least fifty miles by the meanderings of the river, with a large portion of the American Bottom, dotted with lakes and cultivated farms, may be seen at one view, forming one of the finest landscapes to be seen in the State. This is the most westerly extension of the bluffs in the county, and from this point they trend south-eastwardly to the Randolph county line. A half-mile below this the Burlington limestone forms the lower escarpment of the bluff, and with a rapid dip to the southward soon disappears below the surface. No exposure of this limestone was met with in the county, except those occurring in this vicinity.

Kinderhook Group.—This group also owes its outcrop in this county to the disturbing influences by which the Trenton limestone has been lifted above the surface at Salt Lick Point, and, in the absence of the Devonian and Upper Silurian groups, the shales and chocolate-colored limestones of which this group consists immediately overlie the Trenton limestone, as indicated in the foregoing section. The lower portion of the group consists of ashen-gray shales, which pass upward into chocolate-colored shales and limestones, and these form the slope at Salt Lick Point between the two escarpments of limestone, the Burlington above and the Trenton beneath. A few fossils were obtained here, mostly from the chocolate-colored shales and shaly limestones, among which were *Productus Burlingtonensis*, *Spirifer Grimesi*, or a closely allied species, *Spirifer Vernonense*, *Spirigera Hannibalensis*, *Paleacis enorme*, *Actinocrinus pistilliformis*, *Strophomena analoga*, *Conocardium* and *Zaphrentis* of undetermined species. This group overlies, unconformably, the outcrop of Trenton limestone at this point, and dips rapidly beneath the surface in either direction.

Trenton Limestone.—This is the oldest or lowest formation that appears above the surface in Southern Illinois, and it only outcrops at one other point, in Alexander county, where, as here, it forms the nucleus of an anticlinal axis. The first appearance of this limestone in this county, in tracing the river bluff southward, is about two miles below Eagle Cliff, where it forms a low ledge of massive gray limestone at the base of the bluff, a short distance below the point where the main road from Waterloo to Harrisonville enters the river bottom. From this point it rises rapidly to the southward, and a half-mile below where it first makes its appearance it forms a perpendicular cliff nearly a hundred feet in hight, which forms the culminating point of the axis. There appears to have been a dislocation and down-throw of the strata at this point, for below the valley of a small creek which intersects the bluffs on the lower side of Salt Lick Point the lower portion of the bluff is formed by an outcrop of Burlington limestone, the Trenton limestone and the Kinderhook group having both been carried down below the surface, and the beds dip rapidly to the southward, or in the opposite direction to the beds at Salt Lick Point. The point where the dislocation of the strata occurs is now occupied by the creek valley, and consequently the amount of the down-throw could not be accurately determined from the poor exposure of the beds; but I inferred that the amount could not be less than two hundred feet, as neither the Trenton nor Kinderhook groups were to be seen on the southern slope of the axis.

That portion of the Trenton limestone outcropping in this county consists, for the most part, of heavy-bedded, yellowish-gray crystaline and sub-crystaline limestones, intersected with vertical fissures or joints, probably resulting from the shrinkage of the material on crystalization. The beds vary in thickness from one to six feet or more, and contain a few of the characteristic fossils of this horizon, among which *Receptaculites Oweniana*, *Orthis lynx*, *O. testudinaria*, *O. formosus* and *Rhynchonella capax* were obtained at this point.

Along the western face of this limestone escarpment, where it attains its greatest elevation, tall columns of limestone, locally known as the "Stone Chimneys," stand out entirely isolated from the face of the bluff, from which they are now separated by a space of from ten to twenty feet or more in width, the intervening portions of the limestone having been removed by surface erosion. Originally these columns were probably only separated from the adjacent cliff by one of the narrow fissures already mentioned as common in this limestone; but these have gradually widened, by the long continued action of atmospheric influences, until they are now many feet away from the rock to which they were originally united. These columns, seen from below, when the leaves have fallen from the dense forest in which they stand, present a very grand and picturesque view, and resemble the ruins of some ancient castle. Some of them are from forty to fifty feet or more in hight, and others have toppled down, and the huge blocks of limestone of which they were composed now lie scattered along the base of the cliff. There is but one other point in Southern Illinois where this limestone appears above the surface, which is at the "Grand Chain," just below Thebes, in Alexander county, where it forms the nucleus of another anticlinal axis crossing the river at that point. It appears to be stratigraphically equivalent to the "Galena Limestone," the true lead-bearing rock of the Northwest; but we saw no evidences of its being a mineral bearing rock in this portion of the State, nor does it possess the dolomitic character which prevails in its north-western outcrops.

This limestone furnishes the celebrated "Glencoe marble," of Glencoe, in Missouri, and inexhaustible supplies of the same marble, equally as good as that from the locality above cited, might be obtained from the Trenton limestone at Salt Lick Point. A railroad from St. Louis to Chester, down the American Bottom, would render this rock at once available, as well as various other quarries of excellent building stone, that could be opened in every township through which the road would run in this county. The time is not far distant when the demand for such materials will justify the building of a railroad along the foot of the Mississippi bluffs between the points above named.

Economic Geology.

Building Stone.—There is no county in Southern Illinois more abundantly supplied with building stone of various qualities than this, and it is so generally distributed over all portions of the county as to be easily accessible to every neighborhood. The stratified rocks of this county are something more than a thousand feet in thickness, and fully one-half of this may be considered of economical value for all the ordinary uses for which a building stone is required. We will take the several groups, in their descending order, and briefly notice the building material they will afford.

The Coal Measures afford little or no building stone of any value, though in the vicinity of Gall's coal bank the limestone over the coal might be used for rough walls in the absence of a better material from the underlaying groups.

The Chester group will furnish an unlimited amount of excellent building stone, especially from the sandstone that forms the base of the group. This sandstone is from 60 to 75 feet thick, and nearly the whole of it, at some points, may be used as a building stone. It is generally pretty evenly bedded, but sometimes shows a concretionary structure; but where this is the case, as at the quarries east of Waterloo, the rock splits evenly, and can be readily quarried in blocks of the proper size. It works easily under the chisel, hardens on exposure, and may usually be relied on as a durable stone. This sandstone outcrops at many points on Stone creek and Prairie du Long, also on Horse creek and its tributaries, in the south-eastern portion of the county. It is also well exposed on the N. E. qr. of Sec. 6 in T. 2 S., R. 10 W., and at some other points along the synclinal coal basin between this and the river bluffs west of Columbia. The limestones of this group also furnish some very good material suitable for rough walls, especially along the southern course of Prairie du Long creek, in T. 3 S., R. 8. W.

The upper division of the St. Louis group forms the bed rock over a greater surface area than any other formation in this county, and therefore the building stone it affords is more generally used. The rock is mostly a compact, fine-grained, bluish-gray limestone, weathering to a nearly white color, and generally lying in regular beds, varying from a few inches to two feet in thickness. Extensive quaries are opened on the outcrops of this limestone in the vicinity of Columbia and Waterloo, to supply the demand for rough walls, as well as for curbstones and flagging, to which the thin beds of this group are well adapted. Two miles west of Waterloo the upper layers of this group consist of a light-gray or nearly white oolite, in beds from six inches to two feet thick.

The rock is free from chert, and would afford an excellent material for window caps and sills, as it cuts much more easily than the fine-grained limestones below, and is also more uniform both in color and texture. Most of the macadamizing material used in this county is obtained from the hard, bluish-gray limestones of this group.

The lower or Warsaw division of this group is well exposed a half mile east of Columbia, and some portions of it afford an excellent building stone. The upper portion consists of about twenty feet in thickness of a light-gray, granular limestone, entirely free from chert, and in heavy beds, some of which are from three to four feet thick. The rock splits easily, affording dimension stone of any desired form and size. This rock appears to dress well, and is really one of the best building stones in the county. The lower beds of this division are also partly heavy bedded buff or brown limestones, partly magnesian or dolomitic in structure, and afford a durable building stone. This division of the group is well exposed in the river bluffs about a mile and a half below Salt Lick Point, where it forms a bluff more than a hundred feet in hight, nearly the whole of which is a valuable building stone. The Keokuk group is not fully exposed in this county, except along the river bluffs in the southwestern portion, where there has as yet been but little demand for building stone, and no extensive quarries have so far been developed in it. The upper beds seen at Mr. Pryor's place, a mile and a half east of Salt Lick Point, were in tolerably regular beds and comparatively free from chert. The lower sixty feet of the section at the same point consisted of gray limestone, somewhat cherty, but similar to the limestones obtained from this group at more northern localities. The Burlington limestone appears to be more cherty at the outcrops seen in this county than it usually is in the northern portion of the State, and consequently no great amount of good building material may be expected from it.

The entire thickness of the Trenton group might be made available, if it was found at any point where a demand for building stone existed, but as its only outcrop is in the river bluffs, remote from any town, its supplies of useful building material are for the present only of prospective value.

Marble.—The Trenton limestone affords some beds of light gray crystalline thick-bedded rock, that receives a fine polish, and the thickly imbedded organic forms give to the polished surface a slightly mottled appearance that is rather pleasing. This rock is extensively quarried at Glencoe, in Missouri, and is known as the Glencoe marble. It may be obtained at Salt Lick Point, in this county. in inexhaustible quantities, and if railroad facilities were at hand would become a source of considerable revenue to the county.

Coal.—The only coal in this county is that occurring in the small synclinal basin already mentioned, and the area of workable coal is consequently quite limited. At Gall's place the coal is about four feet thick, but it is not very persistent, frequently running down to two feet or less in thickness. The quality of the coal obtained is also inferior to that from the equivalent seam near Centerville, in St. Clair county, and hence the mines here can not be successfully worked in competition with the thicker beds of the main coal field. We are also inclined to believe, from the examinations made, that over a considerable portion of the northern half of this isolated basin the Coal Measure strata have been partially removed by denudation, and are now replaced by drift clays. This is indicated by the frequent occurrence of tumbling masses of the compact gray limestone, which overlies the coal, in the drift clays on the small stream south and south-west of Columbia. The block coal a mile and a half east of Columbia, already described, and which is owned and worked by a citizen of Columbia, Mr. H. F. Henckler, lies mainly beyond the St. Clair county line.

Iron Ore.—A band of iron ore, apparently of good quality, occurs in the vicinity of Henckler's coal mines, at the junction of the Chester and St. Louis groups. At the only point we saw it exposed, it was not above three or four inches thick, but it is quite probable it may be developed somewhere in this county, or in the southern portion of St. Clair, thick enough to become of some economical importance.

Hydraulic Limestone.—The Limestone at the Portland quarries, four miles south east of Waterloo, closely resembles the hydraulic rock oft n found at the top of the Keokuk group. The bed has been exposed in the quarry to the depth of six feet, and the rock is an earthy, buff colored dolomite, very similar in appearance to that used at the cement mills in St. Clair county, and also on the Piasa, in Jersey county. If, on experiment, it should be proved to possess hydraulic properties, the manufacture of cement might be successfully carried on here, as the railroad now building through this county would open a good market for all the cement that could be made.

Limestone for Lime.—First in value and importance for the manufacture of quicklime, is the light bluish-gray compact limestones of the upper division of the St. Louis group, which could be readily worked at more than a hundred points in the county. It is one of the purest limestones in the West, and is more extensively used for the lime kiln than any other. The completion of the railroad through this county will open new markets and facilitate the production of this article. The Trenton limestone at Salt Lick Point, as well as the lower beds of the Keokuk group in the same region, will afford an abundant supply of excellent limestone for this purpose, whenever any demand shall arise for its manufacture in this part of the county. This county might easily furnish the whole Mississippi valley with all the quicklime required for centuries, without exhausting the supplies for this material now so abundantly at hand.

Brick Materials.—Sand and clay suitable for the manufacture of common brick abound in almost every neighborhood, and may be readily obtained. The brown clay subsoil on the highlands is generally well adapted for this purpose, and where there is a deficiency of sand it may be readily supplied from the banks of the adjacent streams.

Soil and Agriculture.—The varied character of the surface in different portions of this county must necessarily result in an equally variable soil and its products. On the bottom lands along the river, and also in the valleys of some of the small streams, the soil is a deep, sandy loam, highly charged with humus from the vegetable matters that have been produced and decayed upon its surface; and this soil is exceedingly productive, yielding annually heavy crops of corn and other cereals usually grown in this climate. These are the most productive lands in the county, and where they are elevated above the annual floods in the Mississippi, are also the most valuable. Next in order are the chocolate-colored soils of the small prairies in the eastern portions of the county, and the timbered lands adjacent thereto, where the underlaying rocks belong to the Chester group. These lands also produce good crops of corn, wheat, barley and clover, but require a judicious rotation of crops, to retain their original fertility. Lastly, we have the oak ridges along the river bluffs, and the sink hole region, underlaid by the upper division of the St. Louis limestone. The soil over this portion of the county is very thin, and consists of yellowish or ashen-gray clays, with a yellow clay subsoil. These lands require heavy manuring, if cultivated in corn, but produce fair crops of wheat and other small grains, and clover, where the surface is not too broken for cultivation. These are the best fruit lands, perhaps, in the county, and apple, peach and pear orchards flourish here, and grapes are also extensively cultivated. All the small fruits might be successfully cultivated on these broken lands, and their near proximity to the St. Louis market would make this branch of horticulture exceedingly profitable, if properly conducted. Vineyards have been successfully cultivated here for many years, and this county probably ranks about the third in the State for the value of its wine products. The completion of the railroad through this county will bring it within a half hour's ride of St. Louis, and will greatly enhance the value of its lands, especially those best adapted to the cultivation of the small fraits.

Before closing my report on Monroe county, I desire to express my obligations to Hon. HENRY TALBOT, of Waterloo, and his son, and also to Mr. H. F. HENCKLER, of Columbia, for their earnest co-operation and assistance in the prosecution of my work while in the county. To Mr. TALBOT and his amiable lady I am also indebted, for the hospitalities of a quiet home, while engaged in working out the geology of the southern portion of the county; and to Mr. HENRY TALBOT, jr., I am indebted for several days' personal assistance, and for many fine specimens collected by himself at various localities in this county.

CHAPTER XVII.

MACOUPIN COUNTY.

This county lies a little to the south-westward of the geographical center of the State, and embraces a superficial area of twenty-four townships, or eight hundred and sixty-four square miles. It is bounded on the north by Sangamon and Morgan counties, on the east by Montgomery, on the south by Madison, and on the west by Jersey and Greene counties.

The principal streams in the county are Macoupin creek, and its tributaries, which intersect the central and northern portions of the county, and Cahokia creek traversing its south-eastern townships. Heavy belts of timber occur on either side of these water courses, which furnish an adequate supply for the prairies that occupy all the highlands between the streams, and cover fully two-thirds of its entire area. The prairies are generally nearly level or gently rolling, and are elevated from fifty to one hundred and fifty feet above the beds of the principal streams.

Surface Deposits.—The Quaternary beds of this county consist mainly of drift-clays, with some interstratified beds of sand and gravel, and some local deposits of loess along the bluffs of the Macoupin. They range in thickness from forty to two hundred feet or more, their greatest development being restricted to the ancient valleys, excavated anterior to, or during the drift epoch, and subsequently filled with drift accumulations. The lower course of the Macoupin south and west of Carlinville appears to occupy in part one of these valleys, and three miles south of Carlinville, a shaft was sunk by T. L. Loomis, Esq., to the the depth of one hundred and sixty feet, without reaching the bed rock, all but a few feet at the top being through a blue hard-pan. At this point a stream of water broke through, probably from an underlaying bed of quicksand, and filled the shaft in a few hours to the depth of about eighty feet, and the work was consequently abandoned.

At Naylor & McPherson's coal shaft, one mile south-east of Bunker Hill, the superficial deposits were only twenty-eight feet thick, while at

Van Horst & Voges' shaft, east of Staunton, they were one hundred and ten feet; at the Virden shaft twenty, and at Girard about seventy feet. These figures illustrate the variable thickness of the drift deposits in this county, and indicate the irregularity of the original surface of the bed rock, which seems to have been intersected by valleys of erosion quite as deep, if not as numerous as those which characterize the surface at the present time. The upper thirty or forty feet of the drift consists of brown or buff gravelly clays, which pass gradually into the blue hard-pan below, which forms the lower division of this deposit. The beds underlaying this hard-pan were not passed through at Loomis' shaft, and consequently their characters are not definitely known, but the great amount of water flowing into it in so short a time, indicates the presence of a bed of quicksand immediately below the hard-pan; and quite probably other beds, including an original surface soil similar to that met with at the Bloomington shaft, and at various other localities in the State, may also be found to exist here.

Stratified Rocks.

All the stratified rocks of this county belong to the Coal Measures, and include all the strata from the horizon of coal No. 4, which outcrops on Hodge's creek, just on the Greene county line, to coal No. 10, inclusive, embracing an aggregate thickness of about three hundred and fifty feet. The following section of the coal shaft at Virden, kindly furnished me by J. W. Utt, Esq., one of the proprietors of the mine, will give a general idea of the relative thickness and position of the strata, and includes nearly all the different beds that outcrop in the county, except a few feet in thickness below the coal worked in this mine, which outcrop on the west line of the county, and also a few feet in thickness of beds overlaying the highest in this shaft, which outcrop on the upper course of Macoupin creek, east of Carlinville.

Virden Shaft.

		Feet.	In.
	Drift clay	20	0
No. 1.	Sandstone	5	0
No. 2.	Bituminous shale	0	5
No. 3.	Coal	0	2
No. 4.	Fire-clay	5	0
No. 5.	Bituminous shale	4	6
No. 6.	Coal No. 10	0	6
No. 7.	Fire-clay or clay shale	6	0
No. 8.	Hard gray limestone	7	9
No 9.	Bituminous shale	1	4
No. 10.	Argillaceous shale	5	6
No. 11.	Compact limestone (Carlinville bed)	7	0
No. 12.	Bituminous shale, Coal No. 9	1	3
No. 13.	Clay shale	6	0
No. 14.	Limestone	0	9
No. 15.	Sandy shale and sandstone	63	0

		Feet.	In.
No. 16.	Soft limestone or calcareous shale	1	4
No. 17.	Bituminous shale	3	10
No. 18.	Coal No. 8	0	10
No. 19.	Sandstone and sandy shale	72	0
No. 20.	Shales with ironstone	3	0
No. 21.	Hard calcareous (?) sandstone	8	0
No. 22.	Blue clay shale	4	0
No. 23.	Variegated shales (Horizon of coal No. 7)	22	6
No. 24.	Sandy shales	26	0
No. 25.	Soft bituminous shale	1	6
No. 26.	Limestone	3	0
No. 27.	Bituminous shale	2	6
No. 28.	Coal.....No. 6	2	9
No. 29.	Fire-clay	2	0
No. 30.	Sandstone	4	0
No. 31.	Coal.....No. 6	1	6
No. 32.	Fire-clay	2	0
No. 33.	Sandstone and shale	10	0
No. 34.	Limestone	[illegible]	0
No. 35.	Bituminous shale	0	6
No. 36.	Coal No. 5	7	8
	Total depth to the bottom of the coal	320	1

A shaft has also been sunk at Girard down to this main coal, but as no record was kept of the thickness and character of the beds passed through, we are unable to designate the changes which mark the various strata between these points.

The coal worked at these shafts, as well as all others at present in operation in this county, is, in my opinion, No. 5 of the general section of the Coal Measures of Western Illinois, as given in the third and fourth volumes of these reports. In the central portions of the county its thickness ranges from six to eight feet, but on Apple creek, in the north-west corner of the county, a coal outcrops that seems to be the equivalent of this, but is much thinner, ranging only from two to three feet, and at Howard's shaft, one mile and a half north of Bunker Hill, its average thickness is about four feet.

At the Virden shaft the main coal (No. 36 of this section) averages about seven feet and a half in thickness, sometimes running up to eight feet, and seldom falling below seven. It is a moderately soft, free burning coal, especially that from the upper portion of the seam, from two to three feet in thickness, which is an excellent smith's coal. The seam is divided by a shaly parting of about an inch in thickness, which is very persistent, and about one-third the distance from the bottom to the top of the seam. The coal has a tendency to break into cubic blocks like the Belleville coal, though the partings which separate the coal into several distinct layers are not as decided here, as at the mines in St. Clair and Randolph counties. No horsebacks or other impediments to the profitable working of this coal has yet been encountered in this shaft. Salt water in small quantities percolates through some of the sandstones above the coal, especially Nos. 19 and 33. The roof consists first, of a dark-blue clay shale, sometimes passing into a hard black slaty shale, an inch or two in thickness, resting directly on the coal. This clay shale varies in thickness from two to three inches to as many feet, and above this there is a compact dark-gray limestone about seven feet thick, which forms an admirable roof to the coal. The shale immediately on the coal is more argillaceous than at the mines in the vicinity of Springfield, and fossils are comparatively rare, even where it becomes hard and slaty. We obtained a few of the common species here, among which were *Discina nitida*, *Productus muricatus*, *Hemipronites crassa*, *Chonetes mesoloba*, some fragments of a *Nautilus*, and teeth of *Petrodus occidentalis*. These fossils were generally poorly preserved, and the shells mostly replaced with yellowish pyrite. This coal seems to be the equivalent of coal No. 5 of the Fulton county section, given on page 93 and 94 of the fourth volume of these reports, though in that county No. 5 is not a very persistent seam in its development. It affords a softer coal than that usually obtained from No. 4, and is more regularly stratified, breaking freely into blocks of a cuboidal form when carefully mined. No attempt has yet been made to determine the development of No. 4, or either of the lower seams in the central portion of the county, but No. 4 outcrops on Hodge's creek, near the Greene county line.

The shaft at Girard is about three hundred and forty feet in depth, but as no record of it was kept by those in charge of the work, no reliable section could be obtained of the strata passed through. The coal averages about seven feet in thickness, has a shaly parting similar to that at Virden, and the coal presents the same general character. The limestone above the coal is somewhat thicker than at Virden, being about ten feet.

Weir's shaft, at Carlinville, is two hundred feet to the top of the coal passing through the following beds:

			Feet.	In.
	Drift-clays		75	0
No. 1.	Clay shale		28	6
No. 2.	Soft coal (No. 8)		0	6
No. 3.	Dark and light fire-clays		5	0
No. 4.	Sandstone and shale		70	0
No. 5.	Clay shale		15	0
No. 6.	Dark shale		6	0
No. 7.	Soft smutty coal (No. 7)		5	0
No. 8.	Fire-clay		6	0
No. 9.	Sandstone		8	6
No. 10.	Clay shale		2	0
No. 11.	Limestone		3	0
No. 12.	Clay shale		1	0
No. 13.	Limestone		1	6
No. 14.	Coal	} No. 6	1	6
No. 15.	Shale		6	6
No. 16.	Coal		0	6

		Feet.	In.
No. 17.	Fire-clay	2	6
No. 18.	Hard rock (probably limestone or calc. sandstone)	12	0
No 19.	Shale	5	0
No. 20.	Limestone	5	0
No. 21.	Black shale	0 to 4	0
No. 22.	Coal (No. 5.)	6	0
		266	2

The coal here is similar in quality to that obtained from the shafts at Virden and Girard, and the mine is entirely free from water, and its gangways as dry as though they possessed a water-proof covering.

Bartel's shaft in the creek valley south of town was commenced at a much lower level, and the coal was reached at a depth of about 210 feet. The coal in this shaft ranges from six to eight feet in thickness, and has a good roof, composed of five feet of bituminous shale and five feet of limestone.

In the section given above of the Carlinville shaft it will be seen that coal No. 6 is divided by a parting of shale six feet and a half in thickness, while at the Virden shaft the parting consists of sandstone and shale, and is six feet in thickness. In the last named shaft this seam would be thick enough to be profitably worked, the two divisions being in the aggregate four feet three inches in thickness, if united, but owing to the great thickness of the parting the seam is valueless, as too great an amount of labor would be required to remove the material separating the two divisions of the coal. This seam has not yet been found in any of the shafts in this county under such conditions as will permit of its being worked successfully. The next seam, No. 7, although of sufficient thickness, was found to be too soft and inferior in quality, and consequently valueless. Coal No. 8 appears to be the equivalent of the eighteen-inch coal outcropping on the breaks of Spring creek near Springfield, and on the Sangamon, at Howlett. It seems to be thinner in all the shafts sunk through it in this county than in Sangamon, usually ranging from six to ten inches only. The sandstone intervening between this and No. 7 is partially exposed on the lower courses of Macoupin and Hodge's creeks, and also on some branches of Apple creek in the north-western portion of the county. The limestone No. 11 of the Virden shaft section is a very hard gray limestone, and outcrops at several points in the vicinity of Carlinville, and is therefore locally called the Carlinville limestone. It ranges in thickness from six to twelve feet or more, and is a compact, brownish-gray rock, weathering to a rusty-brown color on exposure, the lower portion of the bed being usually in regular layers, while the upper portion becomes locally concretionary, or pebbly, in its structure. This limestone forms the bed-rock over a considerable portion ot the county, especially the region between Carlinville and Cummington, and extending from the first named point south-eastwardly to Bunker Hill and Staunton. On the road between the two points last named, on the head-waters of Cahokia creek, two miles and a half north-west of Staunton, this limestone is partially exposed, and is here overlaid by about fifteen feet of greenish shale, with a band of impure earthy iron ore intercalated in it about two feet above the limestone. This band of iron ore closely resembles the fossiliferous ore bed on the north fork of Saline river in Gallatin county, twelve miles north of Equality, and contains several of the same species of fossils obtained there. If these ferruginous beds are identical, as seems highly probable, it fixes the geological position of a group of fossils that have hitherto been considered as more decidedly Permian in their aspect than any others occurring in our Coal Measures, and establishes their stratigraphical position at least three or four hundred feet below the uppermost beds of the Coal Measures in this State. The limestone underlaying this fossiliferous iron ore is about 210 feet above coal No. 5 in this county, and probably from four hundred to four hundred and fifty feet above the base of the Coal Measures, and therefore this iron ore band is not far above the middle of the Coal Measures. The Carlinville limestone outcrops on Macoupin creek, from the vicinity of Corr's mill, north-east of Carlinville, down to the bridge on the Hillsborough and Carlinville road, forming the bed of the creek for several miles by the meanderings of the stream. At the first outcrop below the mill the limestone forms the bed of the creek and only the upper portion of it can be seen. It forms a riffle here across the creek, and the pebbly character of the upper portion gives it the appearance of a bed of coarse gravel rather than an outcrop of limestone. Below these pebbly layers the rock becomes quite evenly bedded in layers from four inches to a foot or more in thickness, and has been quarried for local use as a building stone. In the debris of an old quarry I obtained a few of the most characteristic fossils of this limestone, among which were the following species: *Camarophoria Osagensis*, *Retzia punctulifera*, *Terebratula bovidens*, *Spirifer plano-sulcata*, *S. cameratus*, *S. Kentuckensis*, *Athyris subtilita*, *Productus longispinus*, *Platyostoma*, and *Platyceras*, of undetermined species, *Pleurotomaria turbiniformis*, *Nautilus Tcheffkini ? Phillipsia scitulus*, and *Campophyllum torquium*. At most localities where this limestone is exposed fossils were exceedingly scarce, and difficult to obtain when found, from the very hard and splintery character of the rock in which they were imbedded.

At the coal shaft one mile west of Staunton this limestone is six feet thick, and lies in regular beds, and is quarried for foundation walls and other purposes. The coal at this point lies 210 feet below this limestone, and the seam averages about six feet in thickness. At the coal shaft on the railroad a half-mile east of the town, which is located on the prairie a hundred feet above the level of that west of town, in the valley of Cahokia creek, a hundred and ten feet of drift clays were passed through before reaching the limestone. At the time of my visit to this locality, in September, 1871, the shaft was down to the horizon of coal No. 6, but no accurate record had been kept at either of these shafts of the character and thickness of the strata passed through. The following, given me from recollection by the man in charge of the work in sinking these shafts, is approximately correct. Beginning at the level of the limestone, we have the following:

		Ft.	In.
No. 1.	Limestone	6	
No. 2.	Clay shale	35	
No. 3.	Fire clay (?)	5	
No. 4.	Coal, (No. 8)	0	3
No. 5.	Shales and sandstone, partly arenaceous, and including the horizon of coal No. 7	110	
No. 6.	Red shale	0	4
No. 7.	Limestone	5	
No. 8.	Blue shale	3	6
No. 9.	Coal, (No. 6)	2	
No. 10.	Clay shale	9	
No. 11.	Limestone	17	
No. 12.	Bituminous shale	2	
No. 13.	Coal, (No. 5)	6	

To get the total depth of these shafts we must add ten feet of drift clays to the top of that west of town, and one hundred and ten feet to the top of the other.

In the vicinity of Bunker Hill there are also two shafts in successful operation, one a half mile south-east of the town, of which Naylor & McPherson are the proprietors; and the other, owned by Mr. Andrew Howard, one mile and a quarter north of town, on a branch of Wood river. The shaft south-east of town is two hundred and fifty-three feet in depth, and, although no record was kept of the beds passed through, the following, given me by one of the proprietors, from recollection, is probably approximately correct:

		Ft.	In.
No. 1.	Drift clay	28	
No. 2.	Blue clay shale	12	
No. 3.	Hard gray limestone (Carlinville bed)	8	4
No. 4.	Blue shale	30	
No. 5.	Limestone (?)	2	
No. 6.	Clay shale	1	4
No. 7.	Coal (No. 8)	0	4
No. 8.	Fire clay	2	
No. 9.	Clay shale, with nodules of limestone	8	
No. 10.	Red shale	2	6
No. 11.	Sandstone and shale	55	
No. 12.	Black shale (coal No. 7)	3	
No. 13.	Sandstone (water-bearing)	30	
No. 14.	Shale, with some limestone	15	
No. 15.	Clay shale	3	

No.	Bed		Ft.	In.
No. 16.	Coal	No. 6	1	8
No. 17.	Nodular limestone and shale		10	
No. 18.	Coal		1	6
No. 19.	Limestone		8	
No. 20.	Shale		7	
No. 21.	Limestone		7	
No. 22.	Black shale		2	
No. 23.	Coal (No. 5)		6	
			253	7

The coal at this mine varies in thickness from five to seven feet, and is divided below the middle by a shale parting, the coal above the parting being of a better quality than that below it, and having a tendency to the block character. The coal has a bright glistening color on the faces of transverse cleavage, and the layers are separated by thin layers of charcoal or carbonaceous clod.

At Mr. Howard's mine, in the valley of Wood river, the coal was reached at a depth of one hundred and sixty feet, but as we could obtain no section of the shaft, we are unable to say whether the coal mined here is the same with that in the other shafts or not. The seam is only about four feet thick here, and it may be that it is No. 6 instead of No. 5, that is worked at this point.

In the vicinity of Plainview, the Carlinville limestone is found outcropping on one of the small tributaries of the Macoupin, and following down the railroad grade as it descends into the creek valley, the following beds may be seen:

No.	Bed	Thickness
No. 1.	Compact brownish-gray limestone	6 feet.
No. 2.	Calcareous shale with chonetes, etc	½ "
No. 3.	Dark-blue clay shale, with ferns	3 "
No. 4.	Sandy shales and shaly micaceous sandstones extending below the creek level	50 to 60 "

The buff-colored calcareous shale immediately beneath the limestone was found at one locality filled with fossil shells, *Chonetes*, *Athyris* and *Productus*, but mostly in a crushed and flattened condition. The dark-blue clay shale, No. 3, is partly bituminous, and contains fragments of fossil ferns of two or three species. It seems probable that the Carlinville limestone, No. 1 of the above section, is the stratigraphical equivalent of the Shoal creek limestone, mentioned in the reports on Madison, Clinton and Marion counties, in the third Volume of these reports, and if so, this bituminous clay shale may represent the thin coal immediately below that limestone, which would be coal No. 9 of the general section, and is from eighteen inches to two feet thick in the vicinity of Highland, in Madison county, where it has been worked for many years in a small way, to supply the local demand for coal.

In the section given above, it will be seen that there is a very decided increase in the thickness of the beds intervening between the Carlinville limestone and coal No. 8. Usually the intervening beds are about thirty to thirty-five feet in thickness, but here we have nearly sixty feet in thickness below the limestone without any indication of coal, and this probably results from a local thickening of the sandstone, a repetition of what may be seen in the section of the Virden shaft, where the sandstone, No. 15 of that section, is sixty-three feet in thickness, and the whole distance from the limestone to coal No. 8 is seventy-six feet and two inches. In the bed of Macoupin-creek, about half a mile below Holliday's ford, on section 30, township 9, range 8, we found an outcrop of bituminous shale and thin coal which may probably be considered as representing coal No. 8. The beds exposed here show the following succession.

No. 1.	Clay shale	10 to 12 feet.	
No. 2.	Chocolate colored limestone	1 "	
No. 3.	Bituminous shale	0 "	4 in.
No. 4.	Coal	0 "	2 in.
No. 5.	Fire-clay	2 "	

We obtained a few fossils from the limestone No. 2 of the above section, and among them *Naticopsis ventrica*, a small *Macrocheilus*, and *Lophophyllum proliferum*, all of which are found in the roof of No. 8 coal, in the vicinity of Springfield. If we add to the top of this section the shales and micaceous sandstones of the preceding section, we shall have about the same thickness of strata intervening between coal No. 8 and the Carlinville limestone that occurs in the Virden shaft. Moreover the local thickening of beds of sandstone is by no means uncommon in the Coal Measures, but on the contrary is of frequent occurrence.

There are some excellent exposures of this micaceous sandstone along the creek bluffs just below the railroad bridge. The rock is partly massive, especially the lower portion of the bed, and affords layers two feet or more in thickness, some of which are quite hard and will afford a durable building stone. Silver ore was reported to have been discovered in this sandstone, in a quarry on the south-west quarter of section 20, town 10, range 8 west, a few years since, and an attempt was made to organize a joint stock company for its development. The silvery scales of mica which the rock contained were mistaken by some ignorant persons for silver, and hence the reported discovery of a rich mine of metallic ore at this locality. The only material of economic value this rock contains is building stone of a fair quality, which may be obtained here in abundance.

The best exposures of the beds overlaying the Carlinville limestone, that we met with in this county, are on the upper course of Macoupin creek, commencing eight miles north-east of Carlinville in the vicinity of Coops' Mound, and extending down to the bridge on the Hillsborough road. The succession or relative position of the beds is as follows:

No. 1.	Light yellowish-gray nodular limestone	5 to 8 feet.
No. 2.	Bituminous shale	1 ''
No. 3.	Gray shale	17 ''
No. 4.	Soft coal, No. 11	1 ''
No. 5.	Shale with iron pebbles	7 to 8 ''
No. 6.	Chocolate colored coarse limestone	2 to 3 ''
No. 7.	Green and yellow shales	2 ''
No. 8.	Black shale and poor coal, No. 10	2 ''
No. 9.	Green and gray shale	3 to 4 ''
No. 10.	Carlinville limestone	6 to 12 ''

At Fullerton's mill, on Macoupin creek, eight miles north-east of Carlinville, on the north-east quarter of section 16, town 10, range 6, there is an outcrop of light-gray, irregularly bedded limestone in the banks of the creek, that I am inclined to refer to No. 1 of the above section, although none of the underlaying beds were exposed at that point. The rock is similar in color and general appearance, and contains the same species of fossils, mostly *Athyris subtilita*, *Productus longispinus*, *Rhynchonella Osagensis*, *Terebratula bovidens*, and joints and plates of *Crinoidea*.

Just below Corr's mill, about four miles a little north of east from Carlinville, the lower limestone in the foregoing section appears in the bed of the creek, and between this point and the bridge on the Hillsborough road the beds intervening between these two limestones are partially exposed at several points. The chocolate colored limestone (No. 6) is a coarsely granular rock made up in good part of the joints and plates of *Crinoidea*, but it also contains *Pinna per-acuta*, *Productus Prattenianus P. Nebrascensis*, and the teeth of several species of fossil-fishes, among which we recognized *Petalodus destructor* and *Cladodus mortifer*. In the yellow-clay shale underlaying this limestone, specimens of *Syringopora mult-attenuata* were quite common, and were frequently met with in the rubbles of the creek bed. The thickness of the shales Nos. 7, 8 and 9 of the foregoing section seemed to be quite variable in this vicinity, and at some points probably attain an aggregate of fifteen to twenty feet, but at the best exposure we were able to find they only measured about eight feet, and at some points were still less. The chocolate colored limestone of the above section seems to be identical with that of Sugar creek in Sangamon county, seven miles south of Springfield, where the rock for the old State House was obtained. The thin coals Nos. 4 and 8 of the foregoing section are nowhere thick enough at any of the exposures seen to be of any economical value. It is probable these beds underlie the surface deposits over nearly the whole of the eastern tier of townships in this county. Over a large portion of the two central tiers of townships the Carlinville limestone forms the bed rock, while the western is mainly underlaid by the sandstones overlaying No. 7 coal.

One mile and a half south-east of Cummington the Carlinville limestone outcrops on the breaks of the small streams, and only from thirty to forty feet below the general level of the prairie. It was also found on section 7 in the same township, where it was underlaid by eighteen inches of bituminous slate and shale, representing the horizon of No. 9 coal, and by about fifteen feet of sandy shale and sandstone.

The lowest strata exposed in this county are on Apple creek in the north-west corner, and on Hodge's creek in town 10 south, range 9 west, near the Greene county line. At the locality last named coal No. 5 crops out in the bluffs of Hodge's creek, and has been mined to supply the local demand for coal in that vicinity ever since the first settlement of this part of the county.

At Thomas Bielby's mines, in the bluffs of Hodge's creek, on section 29, town 10 north, range 9 west, the coal ranges from five to seven feet in thickness, and is overlaid by from one to three feet of black shale, forming a good roof. A half mile further south, on a small branch of the creek, the coal is overlaid by a foot or more of black shale. then follows eight to ten feet of hard steel-gray limestone, with intercalations of calcareous shales. Above this is a bed of clay shale, and a second limestone of a lighter color, but weathering to a rusty-brown, and filled with *Fusulina*, which would seem to identify it with the limestone usually overlaying coal No. 6. The section here is as follows:

No. 1	Yellow shale, with thin plates of limestone	4 to 6 feet.
No. 2.	Yellowish gray limestone, with *Fusulina*	4 "
No. 3.	Green shales partly bituminous	6 to 8 "
No. 4.	Steel-gray limestone and calc. shale	8 to 10 "
No. 5.	Black shale	1 to 2 "
No. 6.	Coal No. 5?	5 to 7 "

I am inclined to the opinion that in the shales and limestone forming Nos. 2 and 3 of the section we have a representation of coal No. 6 and its overlaying limestone; and at Mr. Davis' coal bank, about a mile west by south from this locality, the coal is directly overlaid by about two feet of light gray fire-clay, above which there was about two feet of yellowish-gray limestone similar to No. 1 of the above section, which led me to suspect the coal here to be a local development of No. 6. The lowest bed of the foregoing section is undoubtedly the same coal worked in the shafts at Virden, Girard and Carlinville, though the coal contains more pyrite (or sulphur as the miners term it) here, on its outcrop, than in the shafts above named, where it lies from three to four hundred feet below the surface. The coal varies however in this respect in the different mines in this county, and indeed in different portions of the same mines, this sulphurous compound being more abundant at some points than others.

At or near the old strip banks on Hodge's creek, coal No. 4 outcrops at low water, but no exposure was found where its thickness could be accurately determined or its quality ascertained. It was reported to be about two feet thick. Between coal No. 5 and this lower seam there is a bed of nodular argillaceous limestone, which sometimes lies directly under the coal, and at other points is separated from it by a few inches of clay shale or fire-clay, and below the limestone there is from fifteen to twenty feet of sandy shales, extending down to the bituminous shale which forms the roof of No. 4.

The shales and argillaceous limestone immediatey below coal No. 5 contains *Chætetes milleporaceous* in abundance, and at this locality a peculiar group of small univalve shells have been obtained, a number of which have been described in these reports, and will be found illustrated on Pl. 31, Vol. II. These univalves are associated here with *Athyris subtilita*, *Spirifer cameratus*, and some other of the more common forms of the Coal Measures. The upper limestone above the coal at this locality contains *Fusulina*, and joints of *Crinoidea*, which are associated with *Productus Prattenianus* and *P. longispinus*, but fossils are less numerous, both as to species and individuals, in the limestone over the coal here, than in that beneath it. In Fulton county the *Chætetes milleporaceous*, is found in the clay shales or fire-clays under coal Nos. 6 and 7, and it is possible that the Hodge's creek bed should be referred to No. 6 of the Fulton county section, but we are more inclined to regard it as the equivalent of No. 5 of that section, although that is a rather local seam in its development in that county, and Hodge's creek coal a very persistent one here. The thickness of the limestone over this coal is very variable, and ranges from three to ten feet, and where it attains its greatest development, it is usually interstratified with calcareous shale.

On Apple creek, in the north-west corner of the county, the following beds are exposed between Carlin's cannel coal seam, on the north-east quarter of section 3, township 12 north, range 9 west, and the west line of the county, following along the bluffs of the main creek and its tributaries:

No. 1.	Bituminous shale	1	foot.	6 in.
No. 2.	Channel coal, (local ?)	1	"	6 in.
No. 3.	Shale	10 to 12	"	
No. 4.	Compact steel-gray limestone	2	"	
No. 5.	Sandstone and shale	32	"	
No. 6.	Bituminous shale	1	"	6 in.
No. 7.	Coal, (No. 7 ?)	0	"	10 in.
No. 8.	Clay shale	6	"	
No. 9.	Nodular gray limestone	4	"	
No. 10.	Greenish colored shale	12	"	
No. 11.	Brown, coarse-grained limestone	1 to 8	"	
No. 12.	Sandstone and sandy shale	24	"	
No. 13.	Brown argillaceous limestone	3	"	
No. 14.	Shale, mostly argillaceous	1 to 3	"	
No. 15.	Coal, (No. 6 ?)	2 to 3	"	
No. 16.	Clay shale and nodular limestone	8 to 10	"	

On a branch of Apple creek, two miles north of Scottsville, the beds of the foregoing section, from 7 to 16 inclusive, are well exposed, and the lower coal seam has been opened at several points by tunnels driven into the hillsides. It ranges in thickness from two to four feet, and is divided near the middle by a parting of shale from one to two inches thick. The coal is overlaid by two or three feet of clay shale and a bed of argillaceous limestone, which sometimes passes into calcareous shales three or four feet in thickness. The limestone weathers to a rusty-brown color, on exposure, though its color is a light-gray on a freshly broken surface. Where this rock is shaly it afforded some good fossils, among which the *Camarophoria Osagensis* and *Productus longispinus* were the most common. This coal is underlaid, first, by from one to two feet of shaly fire clay, and then a bed of nodular argillaceous limestone containing numerous joints of large *Crinoidea*, associated with *Productus costatus* and *Spirifer cameratus*.

The cannel coal, No. 2 of the foregoing section, was opened at an early day on land owned by Mathew Newkirk, on section 11, township 12 north, range 9 west, and was worked for several years by Mr. John Carlin, to supply the local demand of the neighborhood. The seam varies in thickness from eighteen inches to two feet, the upper part being a true cannel coal and the lower a common bituminous coal. It has proved to be quite local in its development, and has not as yet been met with at any other locality in the county of sufficient thickness to be of any economical value. This seam may be the equivalent of No. 7 coal in the general section of the lower Coal Measures of Fulton county, but we are not sure that it does not hold a still higher position, and is an entirely local seam not represented at all in that section.

The limestone below this coal is also local in its development, not appearing at all on the ravine where the coal was opened, though exposed on another not more than two hundred yards to the northward, and again a mile and a-half east of the old Newkirk mine. The coarse brown limestone is also local in its development and quite variable in thickness, ranging from one to eight feet. Lithologically it resembles a limestone occurring at a much higher level in the vicinity of Virden, and represented by No. 8 of the Virden shaft section.

The sandstone below the coarse-grained limestone, at the locality two miles north of Scottsville, is quite massive and affords a very good building stone. This is also true of the sandstone below the Newkirk coal, No. 5 of the foregoing section, and the upper twenty feet of the bed is a micaceous sandstone impregnated with the oxyd of iron, which hardens on exposure, and affords a reliable building stone.

We were unable to determine the exact horizon of the lower coal, No. 15 of the section, but it seems to be more like No. 6 of the general section than like No. 5. No attempts have been made in this vicinity, by boring or shafting, to ascertain the character of the underlaying beds, and assuming this coal to be No. 6, the main coal worked in all the shafts in this county should be found at a depth of some thirty-five to forty feet below. The reasons which may be urged to sustain this view are the following: The thickness of the seam is only about one half that of No. 5, where it has been identified in other portions of the county, and the limestones, both above and below the coal, differ in their lithological characters, as well as in their fossils, from those associated with coal No. 5. One of the most abundant fossils in the shale over this coal, at its outcrops north of Scottsville, is the *Camarophoria Osagensis*, which I have never found abundant with coal No. 5, and the latter has a peculiar group of univalve shells associated with *Chætetes milleporaceous* in the nodular argillaceous limestone, below the coal, none of which were found in the limestone underlaying the coal at this point. These reasons have induced the belief that the coal on the branches of Apple creek north of Scottsville is coal No. 6, and that No. 5 will probably be found below it, at .the depth of thirty-five to forty feet. At the outcrop on Hodge's creek, near the Greene county line, No. 5 averages about six feet in thickness, and in the central portions of the county, where it has been penetrated by various shafts, its thickness ranges from six to eight feet, averaging nearly or quite seven feet. There is probably no point in this county where this seam is more than 400 feet below the surface, and its greatest depth will be in the townships of range 6 west, the most easterly range of townships in the county.

From an examination of the sections already given, it will be seen that the lowest beds outcropping in the county are found on Hodge's creek, its extreme western border, where coals Nos. 4 and 5 are found exposed in the bluffs of this stream; and one of them has been worked since the earliest settlement of this portion of the county, to supply the local demand for coal. Going eastward from the west line of the county, the surface level gradually increases in elevation, directing the surface drainage of nearly all the streams to the southwestward, which, with a slight eastwardly dip of the strata, carries the coals outcropping along the western borders of the county from 300 to 400 feet below the surface, in the central and eastern portions, where the Carlinville limestones, and the overlaying limestones and shales forming the uppermost thirty-five to forty feet of the stratified rocks in the Virden shaft, are the only beds found exposed on the upper course of the Macoupin and the head waters of Otter creek.

In the extreme southwestern portion of the county, coals Nos. 5 and 6 are found outcropping a mile and a half west of Brighton, just over the line, in Jersey county, and their outcrop has been fully described in the report on that county in Vol. III, p. 108, of these reports. In that vicinity these two coals only average from three to four feet in thickness at the outcrop, but No. 5 evidently thickens to the eastward, in the direction of the dip, as in one of the shafts at Bunker Hill it averages about six feet, and about the same or a little more in the shafts at Staunton. It is probable that Macoupin creek, in its course through township 9 north, range 9 west, may expose some of the shales and sandstones below coal No. 4, but from the wide bottoms and limited exposures of the beds in the creek bluffs, we are unable to decide this point.

In dividing the Coal Measures into an upper and lower division, as seems desirable on many accounts, I am inclined to regard the heavy bed of sandstone and shale, No. 19 of the Virden shaft section, as about the proper horizon where the division should be made, as the beds underlaying this sandstone contain all the heavy beds of coal worked at the present time in this State. There is however one of the upper seams outcropping in some of the eastern counties of the State, that attains locally a thickness of about 3 feet, and is some 300 feet higher in the Measures than this sandstone. Nevertheless, there appears to be a decided change in the coal-forming conditions after the deposit of this sandstone, resulting in thin seams of coal interstratified with calcareous shales and numerous beds of limestone, indicating a more general and long continued submergence of the surface below the ocean's level, and comparatively short periods of emergence, and of true plant-producing conditions. This sandstone is probably the equivalent of the Mahoning and Anvil Rock sandstones of Kentucky, the latter being considered in the Kentucky section as the upper boundary of the workable coals of that State. These sandstones, as I have attempted to show in the chapter on the general distribution of the coal in this State, in Vol. III, p. 7, are most probably one and the same bed, which, at widely separated exposures, were taken to be two distinct sandstones, occupying entirely different stratigraphical positions.

The seven coals underlaying this sandstone range from three to eight feet in thickness, except the upper one immediately below it, which, at the exposures seen in this county, is scarcely developed above one foot in thickness, though at other localities, as in Fulton county, it ranges from twenty to thirty inches, and affords a coal of excellent quality. The coals above the sandstone in this county are Nos. 8, 9, 10 and 11, all of which are too thin to be of any economical value. No. 8, which, in the Virden shaft (No. 18), is only ten inches thick, is probably identical with the eighteen-inch coal outcropping in the vicinity of Springfield, and which, on the Sangamon at Howlet, is two feet in thickness, and affords a coal of very good quality. No. 9 immediately underlays the Carlinville limestone, but in this county seems to be scarcely developed at all, and is usually represented by a thin bed of bituminous shale, locally containing fossil ferns in considerable abundance. No. 10 was found only six inches thick in the Virden shaft, but in the bluffs of the Macoupin, east of Carlinville, it is from twelve to eighteen inches in thickness, but poor in quality where it outcrops. No. 11, in the same vicinity, is only one foot thick at its outcrop, and I could not learn that any attempt had been made to work it in this county. None of these seams are likely to be found thick enough in this portion of the State to be of any economical importance, so long as the vast resources from the lower seams remain unexhausted.

Economical Geology.

Coal.—As may be presumed from the perusal of the preceding pages, coal is by far the most valuable mineral product of this county. Its entire area is underlaid by coal, and the supply from coal seam No. 5 alone is practically inexhaustible; and its resources from this seam, reckoning its average thickness at six feet, which I believe to be a fair estimate, is not less than 5,184,000,000 tons, and will admit of an annual consumption of one million of tons per annum for 5,184 years before the coal from this seam alone would be exhausted. The underlaying beds which have never yet been penetrated in this county, and probably will not be until No. 5 has been thoroughly worked out along the railroad lines, may be safely set down as capable of affording an amount equally as great as that from No. 5, and hence the entire coal resources of this county may be estimated in round numbers at more than ten billions of tons.

Coal No. 5 may be found anywhere in this county that it may be desirable to inaugurate a coal mining enterprize, as it outcrops at the surface on the principal streams that intersect the western border of the county, and in the central and eastern portions it may be reached in shafts varying from three to four hundred feet in depth. Its depth below the Carlinville limestone varies from two hundred to two hundred and twenty feet in the county, and where this limestone is exposed, or where it is known to form the bed rock, the distance to the coal, and the approximate cost of opening a mine in it, can be readily determined.

Coal No. 4 usually lies from thirty to forty feet below No. 5, and the three lower seams, Nos. 1, 2 and 3, will all be found, if developed at all, within one hundred and fifty-feet below No. 4, so that a boring or shaft carried two hundred feet below the main coal in this county, would penetrate all the coals to be found here, and determine positively the amount of coal accessible at any given point where the experiment may be made.

Coal seam No. 5 affords a coal of good average quality, tolerably hard, bright, compact, and usually free from pyrite; it has a rather uneven fracture, but inclines to break into cubic forms, the layers rather thick and separated by partings of carbonaceous clod or mineral charcoal, and contains vertical seams of white carbonate of lime. An analysis of this coal from the Hodge's Creek mines, made by the late Mr. HENRY PRATTEN, former chemist of the geological survey, and published in Dr. NORWOOD'S "Abstract of a Report on Illinois Coals," gave the following result:

Specific gravity	1.2797
Loss in coking	43.48
Total weight of coke	56.52
	100.00
ANALYSIS.	
Moisture	6.50
Volatile matters	36.98
Carbon in coke	48.72
Ashes (white)	7.80
	100.00
Carbon in coal	53.8

This coal is about equal in quality to the Belleville seam in St. Clair county; it is a good steam-producing coal, hard enough to bear transportation, and when carefully selected this seam will afford a good smith's coal. In quality it will compare favorably with the average of our western bituminous coals.

Building Stone.—The Coal Measure strata seldom afford a good building stone, except for foundation walls, culverts and the more ordinary uses to which a coarse and homely material may be used. The Carlinville limestone is the most valuable rock of its kind to be found in this county, and it has been freely used through the central and eastern portions of the county for the ordinary uses above named. In the vicinity of Carlinville, the bed ranges from five to six feet in thickness, and occurs in quite regular layers from four inches to a foot or more in thickness. The rock is compact, fine grained and of a bluish-gray color on a freshly fractured surface, but weathers to a rusty-brown color on exposure. When burned, it slacks freely, and makes a tolerable good but dark colored quick lime. It appears to stand exposure well and has proved to be a durable stone where used for foundation walls, bridge abutments, etc., and is the most valuable limestone in the county for economical purposes.

The coarse brownish gray limestone above the Carlinville bed, which is found in the bluffs of the Macoupin, east of Carlinville, is also a durable stone and has been used for bridge abutments and foundation walls in the vicinity of its outcrop, but as the bed is only from two to three feet in thickness, the supply from this source is necessarily limited. This seems to be identical with the rock at the old State House quarries on Sugar creek, in Sangamon county, though the bed is much thinner here than at that point. The limestone over the main coal, on Hodge's creek, is abundant at some points, but is too argillaceous to withstand the influences of frost and moisture, and therefore not reliable.

Among the sandstones of this county there are at least three distinct beds, that will furnish building stone of fair quality if carefully selected. Two of these beds outcrop on Apple creek and its tributaries, in the north-western corner of the county, and are numbered 5 and 12, in the Apple creek section on page 297. These beds are 24 and 30 feet thick respectively, and are in part composed of a massive brown sandstone that stands exposure well, has an even texture and can be easily quarried in blocks suitable for ordinary building purposes. They are more or less charged with the brown oxyd of iron, which gives to the rock a mottled or speckeled appearance on a freshly broken surface, and as a cementing material adds much to the durability of the stone. There is also a softer micaceous sandstone outcropping on the Macoupin, below the bridge, on the Alton and Chicago railroad, which affords a tolerable good building stone if carefully selected. This bed is No. 15 of the Virden shaft section, and lies from 30 to 40 feet below the Carlinville limestone. These sandstones may probably be found outcropping at other points in the western portion of the county, and, as a general rule, whenever a sandstone is found to present a solid cliff of rock at its outcrop, it may be safely used for all ordinary building puposes.

Limestone for Lime.—The Carlinville limestone has been already mentioned as suitable for lime-burning, making a strong but dark-colored quick-lime, and it is probably the best material for this purpose to be found in the county; but owing to the proximity of the purer limestones of the Lower Carboniferous series at Alton, and the facility for obtaining the very superior quality of lime manufactured at that point, it is not probable that this Carlinville rock will ever be very extensively used for this purpose.

Iron Ore.—A band of very pure carbonate of iron was observed at two or three points on the Macoupin east of Carlinville, intercalated in the shales overlaying the Carlinville limestone, but nowhere in sufficient abundance to be of any economic importance at the present time.

Fire Clay.—The under-clay of coal No. 4 on Hodge's creek, at the single point where we found it exposed, seemed to possess the qualities of a good fire-clay; but the clays under coals Nos. 5 and 6 seemed to be too shaly and impure to be of value for making either pottery or fire-brick. Neither did the under-clays of the thin coals above the Carlinville limestone, at the several outcrops we examined, seem to be pure enough to form a good fire-clay; but as these under-clays frequently change their local characters, it is by no means improbable that they may be found somewhere in the county of good quality.

Sand and Clay for Brick-making.—These materials are abundant in all parts of the county, and may usually be obtained from the beds immediately beneath the soil on the uplands, and where there seems to be a deficiency of sand in the subsoil-clays it may be easily supplied from the beds of the streams, or from the sand-beds interstratified with the drift-clays.

Timber.—Fine belts of timber skirt the banks of all the streams in the county, furnishing an adequate supply for fencing the adjacent prairie, and for fuel to those who prefer wood to coal. The principal growth upon the uplands is two or three varieties of oak and hickory on the ridges adjacent to the streams, while on the more level lands skirting the prairies there are fine groves which, in addition to these varieties, contain elm, linden, wild cherry, honey locust, black walnut and hackberry, and indicate a soil of excellent quality. On the creek bottoms the cottonwood, sycamore, white and sugar maple, ash, redbud, dogwood, sassafras, persimmon, paw-paw and white walnut are common. Since the introduction of the Osage orange for hedges, which are now a common fence in this county, and the introduction of coal as a common fuel, it may be safely estimated that the annual growth of the timber is fully equal to the yearly consumption in this county.

Soil and Agriculture.—This county is situated in the heart of the best corn-producing region in the State, and its prairie lands, which constitute by far the largest part of its area, are unsurpassed among the uplands in this State in fertility, and produce annually large crops of Indian corn, as well as the small grains and grass, without the aid of fertilizers or artificial stimulants of any kind, and with a judicious system of rotation of crops, I believe these lands might be thus cultivated for an indefinite period without any serious deterioration in their productive qualities.

The soil on the level prairie is of a black, peaty character, becoming of a chocolate brown color on the more rolling surfaces, and degenerating into a light ash-gray colored soil on the oak ridges, which are the poorest lands in the county; but these poorer soils upon the broken lands that border the streams are excellent fruit lands, and also produce good crops of wheat and clover, if properly cultivated. Underdraining would no doubt greatly benefit the prairie soils, as the crops are much injured in excessively wet seasons from the superabundance of moisture absorbed by the soil and held by the impervious clays of the subsoils beneath until dissipated by surface evaporation.

The bottom lands in this county are restricted to a narrow belt along the lower course of the Macoupin, and some portion of this has been cleared of the heavy growth of timber with which it was originally covered, and brought under cultivation, and in its productive qualities it ranks with the best prairie soils, especially in the growth of corn. We did not find a single tract of land of a hundred acres in extent, during our explorations in this county, that would not well reward the labor of the industrious husbandman, if brought under cultivation, with an ample crop of some of the fruits or cereals usually cultivated in this climate.

Natural Mounds.—There are some natural mounds in the eastern portion of the county, among the most conspicuous of which is Coop's Mound, eight miles north-east of Carlinville. This mound covers an area of several square acres, and is about sixty feet in hight above the level of the adjacent prairie. It was originally covered with a heavy growth of oak and hickory, and from its summit a beautiful view of the surrounding country may be seen. So far as could be seen from the shallow cuts made by the surface drainage, it seems to be composed entirely of the common yellow gravelly clays that form the upper portion of the drift in this region, and its formation is probably due to the erosion of the surrounding surface after the accumulation of the drift deposits.

In closing my report on this county, I take pleasure in expressing my obligations to GEO. H. HOLLIDAY, Esq., and Judge T. L. LOOMIS, for valuable information and personal assistance, and to the former gentleman for several rare and valuable fossils collected by himself from the Coal Measure limestone and shales of this county. Also to M. UTT, of Virden, and Mr. WEIR, of Carlinville, for correct sections of the coal shafts at those points.

CHAPTER XVIII.

SANGAMON COUNTY.

Sangamon county lies nearly in the geographical center of the State, and embraces an area of sixteen full and several fractional townships, or about eight hundred and seventy-five square miles. The surface is generally quite level, or gently rolling; the general prairie level being from fifty to seventy-five feet above the Sangamon river. It is bounded on the north by Menard and Logan counties, on the east by Macon and Christian counties, on the south by Christian, Montgomery and Macoupin, and on the west by Morgan, Cass and Menard.

The Sangamon river traverses the entire extent of the county from east to west, and with its tributaries furnishes a reasonable supply of water, in ordinary seasons. This stream, as well as its main affluents, are skirted with belts of excellent timber, which makes this one of the best timbered counties in the central portion of the State. About one-third of the county was originally covered with timber, but much of the timbered land has been cleared up and brought under cultivation. The principal varieties of timber observed in this county are the following—and it will be seen that the list embraces nearly every variety of forest tree that is found in the central portion of the State: Sugar and white maple, buckeye, shellbark hickory, swamp hickory, mocher nut and thick shellbark hickory, hornbeam, serviceberry, hackberry, red bud, dogwood, red thorn, black thorn, persimmon, waahoo, white, blue and black ash, coffee nut, black and white walnut, mulberry, sycamore, cottonwood, wild plum, wild cherry, crab apple, white oak, scarlet oak, chestnut oak, laurel oak, red oak, pin oak, swamp white oak, bur oak, sumac, elder, sassafras, linden, willow, American elm, slippery elm, prickly ash, pawpaw, red birch, hazel, spiceberry and honey locust.

The superficial deposits in this county comprise the three principal divisions of the Quaternary: alluvium, loess and drift. Narrow belts of alluvial bottom skirt the Sangamon through a large part of its course in this county, but they are subject to be annually overflowed by the river floods, and are most valuable for the heavy growth of timber they sustain.

The loess covers a large part of the uplands to the depth of from six to twenty feet, and is composed of its usual marly beds of buff and gray sands and sandy clays. Underneath the surface soil at Springfield we usually meet the following succession of beds;

No. 1.	Soil	1 to 2 feet.
No. 2.	Buff colored, silicious clay	2½ to 3 "
No. 3.	Very fine gray, marly sand	3 to 4 "
No. 4.	Brown drift clays, usually extending down to the bed rock	30 to 40 "

Nos. 2 and 3 of the above section may properly be referred to the loess, and at several points in the vicinity of the city, it has been found to contain the characteristic shells usually found in it. I am indebted to Mr. JOSEPH MITCHELL, who has dug many wells in the north-west part of Sangamon county, and in the adjoining portion of Menard, for the following section of the beds usually passed through by him:

No. 1.	Soil	1 to 2 feet—6 in.
No. 2.	Yellow clay	3 "
No. 3.	Whitish (gray?) jointed clay, with shells	5 to 8 "
No. 4.	Black muck, with fragments of wood	3 to 8 "
No. 5.	Bluish colored boulder clay	8 to 10 "
No. 6.	Gray hard pan (very hard)	2 "
No. 7.	Soft, blue clay, without boulders	20 to 40 "

No. 3 of this section is undoubtedly loess, and he affirms that this order of succession was invariably observed at many different localities in that portion of the county, the black, mucky soil always appearing immediately below the loess, and varying from three to eight feet in thickness, and always overlaying the true drift or boulder clay. This old soil is probably the equivalent of a chocolate colored band a foot or more in thickness, which lies at the base of the loess in the bluffs at Quincy. In my report on Adams county, published in Vol. IV, p. 45, I suggested that the layers of chocolate colored soil at the base of the loess observed there, might be the equivalent of the old Post Tertiary soil penetrated in the shaft at Coatsburg, and in consequence of the absence of true drift deposits at Quincy, it was difficult to fix the relation which this chocolate colored soil might hold to the boulder clays, but the occurrence of a similar deposit at so many different localities in this county, at the base of the loess, and always above the boulder clays, seem to indicate pretty conclusively that the stratum at Quincy also belongs above the true drift, and to a more recent period than that penetrated at Coatsburg. These two ancient soils, the one at the base of the loess, and the other below the boulder clay, belong to distinct and widely separated periods, and indicate two distinct emergencies of the surface during the Quaternary period, and the prevalence of conditions suitable for the growth of an arboreal vegetation.

The boulder clays, or true drift, consists for the most part of brown, gravelly clay, with small boulders. Occasionally, a boulder two feet or more in diameter is met with in the beds of the ravines, but they are not common. In the vicinity of Springfield this division of the Quaternary ranges from twenty to forty feet in thickness, and this is probably not far from its average thickness throughout the county; but at some localities there is a blue clay or hard pan below the brown clays, which attains about the same thickness as the former, making the aggregate thickness of the drift, where fully developed, from fifty to eighty feet. No fossils have as yet been obtained from the drift in this county, so far as I am aware, though the tooth of a mammoth was found some years ago in the bluffs of the Sangamon, and near the surface, and probably came from beds not older than the loess.

The discovery of the Niantic mastodon, some three years since, between Illiopolis and Niantic, and just over the Macon county line, excited considerable interest when the discovery was first announced, and I visited the locality, and was present when a part of the bones were taken out. The discovery was made on the farm of Wm. F. Correll, in sinking a stock well, in a wet, spongy piece of ground, located in a swale or depression of the surface, that had evidently once been a pond of water, and had been filled up by the wash from the surrounding highland, until it formed a morass, or quagmire, in dry weather. The bones were about four feet below the surface, and partly imbedded in a light gray quicksand filled with fresh water shells, *Planorbis*, *Cyclas*, *Physa*, etc. Above this quicksand there was four feet of black, peaty soil, so soft that a common fence rail could be easily pushed down through it. The quicksand had evidently once formed the bottom of a fresh water pond, fed probably by springs, and was the resort of the animals whose bones were found here. The first bone met with in sinking the well was one of the tusks, and supposing it to be a small tree, it was cut in two with an ax before its true character was suspected. The other tusk was taken out whole, and measured nine feet in length around the curve, and about two feet in circumference where it was inserted in the skull. The lower jaw, with the teeth in place, and the teeth of the upper jaw, and some of the smaller bones, were also found in a good state of preservation. A fine pair of antlers of the elk, with some other bones of the same animal, and bones of the buffalo and deer, were found in the same position as the bones of the mastodon, but the bones of the smaller animals, although imbedded at the same depth, were lighter colored, less decayed, and appeared to have been buried at a more recent period. The depth of the quicksand was not fully ascertained, but it was probed to the depth of two feet or more without reaching a solid bottom.

Stratified Rocks.

The stratified rocks outcropping at the surface in this county all belong to the upper Coal Measures, and overlie all the main coal seams worked in the State. The lowest beds exposed in the county are found on the Sangamon river, near the Menard county line, and on Richland creek, one of the southern affluents of the Sangamon, in the western part of the county. They consist mainly of sandstones and shales, including the horizon of the Rock creek limestone, although we have not as yet seen any outcrop of this limestone in Sangamon county.

A vertical section of all the beds exposed on the Sangamon and its tributaries, in the central and western portions of the county, would show the following relative position and thickness of strata:

No. 1.	Sandy shales and soft sandstones	15 to 20	feet.
No. 2.	Hard, gray limestone, partly brecciated	10 to 12	"
No. 3.	Black, slaty shale	2 to 3	"
No. 4.	Clay shale	4 to 6	"
No. 5.	Brown, calcareous sandstone, passing into a ferruginous limestone	4 to 5	"
No. 6.	Clay shale, partly bituminous	4 to 6	"
No. 7.	Hard, gray limestone (Carlinville limestone)	6 to 8	"
No. 8.	Sandy shales and soft sandstone	30 to 40	"
No. 9.	Argillaceous limestone and calcareous shales	2 to 3	"
No. 10.	Bituminous shale	1	"
No. 11.	Coal No. 8	1 to 2	"
No. 12.	Fire clay	2 to 3	"
No. 13.	Impure limestone (local)	4 to 6	"
No. 14.	Sandy shales and soft sandstones, with local bands of argillaceous and bituminous shales	50 to 60	"
No. 15.	Hard, gray limestone	2 to 6	"
No. 16.	Shales—sandy, argillaceous and bituminous, with a thin seam of coal	30 to 40	"

The beds numbered from one to seven inclusive, of the above section, are well exposed on Sugar creek two miles north of Virden, and thence down the creek to the crossing of the St. Louis, Alton and Chicago railroad, between which points all the beds included in these numbers outcrop in succession, the eastward dip of the strata being somewhat less than the fall of the stream. The upper limestone, No. 2 of the above section, is well exposed near the bridge on the main road north of Virden, and has been quarried both for lime and for building stone. The upper part of the bed is a nodular, unevenly bedded rock, partly brecciated, while the lower portion is more evenly bedded, affording a tolerably good building stone, in layers from four inches to a foot or more in thickness. A little farther up the creek, the whole mass becomes brecciated and fragmentary, and quarries in pebbly fragments suitable for macadamizing material. The brown ferruginous bed No. 5 of the foregoing section is a hard massive rock, resembling the limestone at Crow's mill, on Sugar creek six miles south of Springfield, of which it is probably the equivalent. It contains numerous fossils, among which are *Productus costatus*, *P. Nebrascensis*, *P. Prattenianus*, *Spirifer cameratus*, *Athyris subtilita*, *Terebratula boridens*, *Pinna per-acuta* and *Myalina ampla?* The limestone No. 7 of the foregoing section is not fully exposed, but the upper layers outcrop in the bed of the creek just above the railroad bridge in pebbly layers, not unlike the upper layers of No. 2 as they appear above the bridge on the main road north of Virden. This outcrop is very similar in appearance to the upper layers of the Carlinville limestone just below Corr's mill, on Macoupin creek, north-east of Carlinville, and I have no doubt but this limestone on Sugar creek is the equivalent of that. Below the railroad bridge, the shales underlaying these limestones are the only beds exposed for some distance, but east of Auburn the limestones are again met with, and are found in occasional outcrops from this point to Crow's mill, seven miles south of Springfield, where the rock for the old State House was obtained. At Peddicord's quarries on Sugar creek the State House rock is well exposed, affording the following section:

No. 1.	Thin bedded ferruginous limestone	2 to 3 feet.
No. 2.	Massive coarse-grained limestone	4 "
No. 3.	Clay shale partly bituminous	6 "
No. 4.	Thin bedded limestone	3 to 4 "
No. 5.	Sandy shale	10 to 12 "

The material for the old State House was obtained mainly from No. 2 of the foregoing section, and there is a nearly continuous outcrop of these beds from this point to Crow's mill two miles below, where the old State House quarries were located. This rock is a coarse-grained brownish-gray crinoidal limestone, almost entirely composed of crinoidal joints and the calcareous remains of marine mollusca, cemented together by calcareous and ferruginous sediment. In addition to the fossils already enumerated as occurring in this limestone at the locality north of Virden, the quarries here afforded numerous specimens of *Syringopora multattenuata*, which seems to belong in the clay shale under the limestone No. 2 of the foregoing section, and so far as I am aware has been found nowhere else but in this shale in Sangamon and Macoupin counties. Some of the masses obtained on Sugar creek are nearly a foot in diameter. This limestone has also afforded fine specimens of *Cladodus mortifer*, *Petalodus destructor*, and *Cyathocrinus Sangamonensis*. This rock possesses the same lithological characters, and affords exactly the same group of fossils as the upper division of the main limestone at LaSalle, and I have no doubt they are stratigraphical equivalents. Below Crow's mill to the outlet of Sugar creek into the Sangamon river, the sandy shales and sandstones intervening between this limestone and the little coal outcropping at Howlett, are the only beds to be seen.

This coal seam, numbered 11 in the general section given on a preceding page, ranges in thickness from eighteen inches to two feet, and is coal No. 8 of our general section of the Coal Measures given in Vol. III, page 5, of these reports. It outcrops in the bank of the Sangamon river at Howlett, and on Spring creek and its branches north and west of Springfield; and previous to the discovery of the heavy beds below this, it was extensively worked in strip banks, and by tunnels along its line of outcrop. It is overlaid by a calcareous shale, and argillaceous limestone, which are wonderfully rich in fossils, and have afforded more than sixty species of the shells, corals and crinoidea characteristic of the upper Coal Measures. The coal is underlaid with a dark bluish-gray fire-clay two or three feet in depth, below which an impure nodular limestone is sometimes found, but more frequently the fire-clay res's directly upon the sandy shales and sandstones below. At Howlett, the argillaceous limestone overlaying this coal seam is succeeded by sandy shales, passing upward into soft micaceous sandstones, which outcrop along the railroad grade just beyond Camp Butler, and contain an intercalated seam of poor coal, only a few inches thick. The limestones of Sugar creek, which properly overlay this sandstone, are not found in the vicinity of Howlett, having been probably removed in the erosion of the Sangamon valley.

Below this coal where it outcrops west of the city, we find a bed of sandy shale and sandstone from thirty to forty feet thick, that locally furnishes some building stone of fair quality, the thick bedded portions being partly concretionary in structure, the concretions often attaining a diameter of five or six feet or more. They are exceedingly hard but may be split into blocks of suitable size, and make a very durable building stone.

At Carpenter's mill, five miles north of Springfield, a fine exposure of the sandstone underlaying this coal may be seen on the north bank of the Sangamon, where it forms a perpendicular cliff more than fifty feet in hight. The upper and lower portions of the formations are thin bedded and shaly, but the middle portion, nearly twenty-five feet in thickness, is in tolerably heavy and evenly stratified beds, ranging from six inches to two feet or more in thickness. These thick layers seem to harden on exposure and afford a very good building stone.

In a ravine a little to the west of the road on the north side of the river, the coal No. 11 of the foregoing section, and overlaying argillaceous limestone were found well up towards the top of the hill, and apparently above the sandstone exposure at the bridge. The limestone here contains the same species of fossils so abundant in the roof of this coal in the vicinity of Springfield. The coal was not well exposed, but does not appear to be more than a few inches in thickness, and this exposure is probably on or near the most westerly outcrop of the seam on the north side of the river.

Among the fossils common in the limestone and shales over this coal the *Lophophyllum proliferum* is very abundant, and is associated with *Astartella vera*, *Pleurotomaria sphærulata*, *P. Grayvillensis*, *P. carbonaria*, *Bellerophon carbonaria*, *B. Montfortianus*, *B. percarinatus*, *B. Stevensianus*, *Leda bella-rugosa*, *Nucula ventricoso*, *Polyphemopsis per-acuta*, *P. nitidula*, *Soleniscus typicus*, *Loxonema rugosa*, *L. cerithiformis*, *Macrocheilus inhabilis*, *M. ponderosus*, *M. medialis*, *M. intercalaris*, *M. pulchella*, *M. ventricosus*, *Euomphalus rugosus*, *Productus longispinus*, *P. Nebrascensis*, *P. Prattenianus*, *Spirifer cameratus*, *S. Kentuckensis*, *Athyris subtilita*, *etc.*

The Rock creek limestone of Menard county, if it extends this far to the eastward, should outcrop on the Sangamon not very far below Carpenter's mill, as its place in the vertical section is between coals Nos. 7 and 8; but all these Coal Measure limestones are somewhat local in their development, and this bed has not been met with, so far as I know, in any of the coal shafts that have been sunk in this vicinity.

The main coal, No. 5 of the general section of the Coal Measures in the central and western portions of the State, lies about one hundred and seventy-five feet below coal No. 8 in the vicinity of Springfield, and from two hundred to two hundred and ten feet below the general surface level. A boring for artesian water was made at Springfield in 1858, and was carried down to the depth of nearly twelve hundred feet without finding water that would rise to the surface, and the parties having the work in charge reported no coal below the small seam thirty or forty feet below the surface, though it was evident, from the character of the material brought up with the sand-pump, that they must have passed through from four to five hundred feet of Coal Measure strata. Subsequently, in a boring at Howlett, a six foot seam of coal was found at a depth of about two hundred feet. A shaft was immediately sunk, and extensive mining operations have been carried on there to the present time. The boring at Springfield not only passed through this seam, but all those underlaying it, of which two or three will probably be found of workable thickness, the men in charge of the work being apparently entirely unconscious of the true character of the strata through which their drill passed. If this work had been placed in the hands of competent men, and an accurate journal of the boring kept, we should now know exactly what our coal resources are, whereas nothing was known in regard to the development of the lower coals, except from the examinations of their outcrops along the Illinois river bluffs, until borings at Jacksonville and Chapin showed the existence of a seam at those points between three and four feet in thickness, which is probably coal No. 3 of the Illinois river section. The dip of the strata in the vicinity of Springfield appears to be about six feet to the mile to the eastward, and a boring at Decatur of a little over five hundred feet in depth failed to reach No. 5 coal. At the depth of about three hundred and forty-five feet they found a hard gray limestone eleven feet six inches in thickness, which I believe to be the Carlinville limestone, and if so the boring would have to be carried from sixty to ninety feet further to reach the coal that is mined in this city and vicinity.

A section of the Howlett shaft, given below, will show the thickness and relative position of the beds to be passed through to reach coal No. 5 in the central part of this county, commencing at the bed-rock below the drift:

		Feet.	In.
No. 1.	Gray sandy shale	20	
No. 2.	Black shale	3	
No. 3.	Coal No. 8	2	
No. 4.	Fire-clay	2	
No. 5.	Impure limestone	3	
No. 6.	Gray sandstone	18	
No. 7.	Sandy shales	49	9
No. 8.	Blue clay shale	16	2
No. 9.	Limestone	3	
No. 10.	Black shale	1	
No. 11.	Coal No. 7	0	2
No. 12.	Fire-clay	4	6
No. 13.	Red and blue shales	11	4
No. 14.	Hard rock (limestone?)	3	6
No. 15.	Variegated shales	9	6
No. 16.	Limestone	8	
No. 17.	Reddish shale	2	
No. 18.	Thin coal No. 6	0	5
No. 19.	Fire clay	7	6
No. 20.	Sandstone and shale	32	
No. 21.	Limestone	1	6
No. 22.	Black shale	2	6
No. 23.	Coal No. 5	6	
		206	10

The next shaft sunk in the vicinity of Springfield was that of Mr. Jacob Loose, two miles south of the city, at the junction of the Toledo, Wabash and Western, and the St. Louis, Alton and Chicago railroads. Beard and Sanderson's shaft is one mile north of the city, and Starne and Shutt's just west of the city limits, on the line of the Springfield and Southeastern railroad. This last named shaft is located in a creek valley, and the coal was reached at the depth of about one hundred and fifty feet. All these shafts are upon the same seam, which averages about six feet in thickness, with an excellent roof of bituminous shale and limestone.

Going west from Springfield, this seam gradually rises towards the surface, and at Pleasant Plains the coal is found at the depth of about one hundred and ten to one hundred and twenty feet below the general surface level. The first shaft sunk here, that of Messrs. Claiborne & Co., is located in the valley of a little branch about a mile north of the village, and the coal was reached at the depth of about eighty feet. The following is a section of this shaft:

		Feet.	In
No. 1.	Drift clay, with tumbling masses of limestone at the bottom	55	
No. 2.	Hard argillaceous limestone	0	8
No. 3.	Blue shale	21	
No. 4.	Bituminous shale	4	
No. 5.	Coal	6	

At the Pleasant Plains shaft, a half-mile east of the village, the coal was found at the depth of about eighty-three feet, passing through a thin seam at the depth of forty five feet, which probably represents No. 6. The main coal in this shaft averages about six feet in thickness, and has a good roof of bituminous shale and limestone. This shaft, like the one north of the village, is located in a creek valley some thirty or forty feet below the general level of the adjacent prairie. No accurate section of this shaft was preserved, and I was unable to learn whether the Rock creek limestone was found in it, but it must underlie the western portion of Sangamon county at no great depth below the surface, unless it has been swept away by denuding forces. All the building stone used in the vicinity of Pleasant Plains comes from Rock creek in Menard county, and hence we may conclude that there is no outcrop of the bed in Cartwright township.

At Barclay station, on the Gilman, Clinton and Springfield railroad, a shaft has recently been sunk, and the coal was reached at the depth of about 250 feet. For the following section, furnished by Mr. R. D. LAWRENCE, superintendent, I am indebted to L. A. FULLER, Esq., of Springfield:

Section of Barclay Coal Shaft

	Feet.	In.
Yellow clay	17	
Hard pan	20	
Gray shale	10	
Coal No. 9		8
Fire clay	1	
Gray shale	70	
Black slate		4
Coal No 8	2	
Fire clay	3	
Blue shale	6	
Hard, variegated rock	5	6
Black slate	1	8
Coal and rock mixed	1	8
Fire clay	2	6
Gray shale	26	
Coal (No. 7?)		1
Fire clay	1	6
Soft sandstone	17	
Black slate		[illegible]
Coal (No. 6?)		2

	Feet.	In.
Fire clay	4	
Blue shale	16	
Sandstone	10	
Gray shale	14	
Hard limestone	15	
Black slate	4	
Coal No. 5	6	1
Fire-clay	4	
Hard, gray rock	8	
	267	1

Coal No. 6, which is usually from thirty-five to forty feet above No. 5, and is generally well developed in Fulton and Peoria counties, has not yet been found in this county of sufficient thickness to be of any economic value. At Beard & Sanderson's it was found to be three feet thick, on sinking the shaft, but on drifting on it, it soon thinned out; and at the other shafts it was only a few inches in thickness. When well developed, it affords a fine, soft, bright coal, free from pyrite, and an excellent blacksmiths' coal. By referring to the report on Fulton county, in Vol. IV, p. 93, of these reports, the reader may see the continuation of the section from coal No. 5 to the base of the Coal Measures, and the relative position and thickness of the coal seams that probably underlay the main coal now worked in this county. The limestone found in tumbling masses at the base of the drift clays in Claiborne & Fink's shaft, near Pleasant Plains, seemed to be the same rock as that outcropping on Rock creek, in Menard county, at Cogdale's quarries. This limestone is a fine-grained, compact, bluish-gray rock, susceptible of a fine polish, and makes a beautiful marble, of a mottled-gray color. It burns into an excellent white quicklime, and the quarries furnish an abundant supply of material for lime burning and for building stone. This limestone is usually from 100 to 115 feet above No. 5 coal, though in Menard county it is only about 85 feet. I regard it as the stratigraphical equivalent of the limestone at Lonsdale's quarries, in Peoria county, and the Collinsville limestone, near Collinsville, in Madison county, where it lies about 115 feet above the coal seam mined at that point, which is probably No. 5. This limestone varies in thickness from five to fifteen feet, is generally even-bedded and in tolerably thick layers in the lower part of the bed, and thin-bedded and nodular in the upper part, where the bed is fully developed. At the outcrop of this limestone about a mile south of the New Salem mills, in Menard county, a huge cyathophylloid coral, sometimes two feet or more in length, and from two to three inches in diameter, is quite common. At the quarries near Collinsville, we have obtained numerous specimens of the *Axophyllum rudis*, of White and St. John, and this is the only locality in the State, so far as I am aware, where this fine species has been found. It is associated with *Bellerophon carbonaria*, *B. nodocarinatus*, *B. Stevensianus*, *Pleurotomaria Grayvillensis*, *Schizodus*, *Platyostoma Peoriense*, *Pinna per acuta ?* and *Petalodus destructor*. If we divide the Coal Measures at all in this State, this limestone may very properly be included in the upper division, as it contains at least three or four species of fossils that we have not seen in any lower horizon. This limestone will probably be found in the bed of the Sangamon river somewhere in Springfield township, unless it has been swept away by erosion.

In the eastern portion of the county rock exposures are rarely met with, and the few that are to be seen are mainly shaly sandstones and sandy and argillaceous shales. At the mouth of Clear creek some beds of shaly sandstone are found, which are probably the equivalents of the soft shaly sandstone forming the top of the bluff on the east side of the Sangamon, near Howlett.

There are probably from seventy-five to a hundred feet of shales and sandstone, belonging above the limestones on Sugar creek, which outcrop along the breaks of the Sangamon between Howlett and the east line of the county, but the exposures are so local and widely separated, that no satisfactory section can be made from surface exposures. They include a thin seam of coal, which, in the boring at Decatur, was twelve to fifteen inches thick, and about 250 feet below the surface.

Commencing at the west line of the county, the main coal worked in the shafts in Sangamon and Macoupin counties, which I believe to be No. 5 of the general section of our Illinois coals, is found at the depth of 120 to 150 feet below the general prairie level, and it dips eastwardly at the rate of about six feet to the mile, and in the central portions of the county it will be found from 200 to 250 feet below the general level, and in the eastern portion, from 300 to 400 feet, to which we may add the additional surface elevation of the eastern part of the county. No borings have yet been made at any of the coal shafts to determine how many of the seams underlaying No. 5 are developed in this portion of the State to a sufficient thickness to be profitably mined, but it is probable there are three or four underlaying seams, that will range from two to four feet in thickness. The supply from No. 5, however, is so great, that it will probably be many years before any serious attempts will be made to mine the lower seams in this county. At every point in the county where a reliable boring has been made, or a shaft sunk to the horizon of this coal, it has been found well developed, being usually from five to seven feet in thickness, with an excellent roof of bituminous shale and limestone. None of the shafts in this county are troubled with water, and in most of the mines the rooms are as dry as an ordinary underground cellar.

Economical Geology.

Coal—From what appears on the foregoing pages, it will be seen that coal is by far the most important mineral resource of this county, and is destined hereafter to exert a very important influence upon the industrial interests of its inhabitants. The general development of the industrial interests of a people is more dependant upon its fuel resources than upon any other to be found beneath the soil, and in all calculations upon the probable future wealth and prosperity of a community, an abundant and cheap supply of coal must form one of the essential elements to be taken into account. More especially is that the case in this Western country, where a comparatively level surface, and consequently sluggish streams, furnish no water power of any value for manufacturing purposes. The value of the coal deposits of this State can hardly be estimated in dollars and cents, and the mighty influence they are destined to exert upon the future wealth and prosperity of its inhabitants can scarcely be overestimated. We have a soil of unsurpassed fertility, producing annually large crops of all the cereals grown in a temperate climate; wonderfully productive in the grasses most conducive to the growth of stock and the production of wool; and beneath the surface we find stored away inexhaustible supplies of fuel, for manufacturing cheaply all the products of our own soil, and also for smelting the iron and other metallic products of adjoining and less favored States.

The coal seam now worked in the shafts in this county will furnish at least five millions of tons of coal to every square mile, or section of land in the county, and that is probably less than one half the full resources of the county in fossil fuel. There are certainly four seams in other portions of the State, which underlay the main coal worked in this county, having an aggregate thickness of about twelve feet of solid coal, and there can be no reasonable doubt but some of them will be found here thick enough to work when the one now mined is exhausted. With such fuel resources at command, there is no reason why Central Illinois should not become a great center of iron manufacturing interests, for it seems to be a well settled proposition that it is cheaper to transport the ores to the fuel, than the fuel to the ores. We have the fuel in almost inexhaustible quantities, and by the improved methods of smelting, our coals are equal in value to the block coals of Indiana, and no good reason can be assigned why this portion of the State should not soon become as noted for the production of iron and steel as it now is for beef and corn. Located, as it were, midway between the great iron ore deposits of Michigan and Wisconsin on the north, and those of Missouri on the south, they must eventually become tributary to Illinois for the means of rendering their vast deposits of iron available as a part of the great industrial resources of the West.

Springfield, with its system of railroads radiating in all directions, is favorably located as a center of important iron and steel manufacturing interests, and it only requires that a knowledge of the resources and facilities here existing should be generally disseminated, to concentrate here the capital and skill required for such enterprises.

Building Stone.—The central and western portions of the county are tolerably well supplied with both limestone and sandstone for ordinary building purposes. The limestone on Sugar creek, from which the material for the old State House was obtained, is a durable stone when laid in a dry wall, but splits into thin fragments if subjected to the combined influences of frost and moisture. The bed is from four to six feet in thickness. It outcrops on all the tributaries of the Sangamon in the south part of the county, and on Sugar creek it is met with at intervals from the bridge north of Virden, where the quarries are located, near the Macoupin county line, to Crow's mill six miles south of Springfield.

The best sandstone in the county for building material is that underlaying the little coal (No. 8) of the general section, but in the section of the formations outcropping in this county, given on page 309, it is numbered 11. Its entire thickness is about sixty feet, but only the middle portion, some twenty feet or more in thickness, where the layers are from six inches to two feet thick, can be safely used for a building stone. At Carpenter's mill, and at some of the outcrops west of the city of Springfield, extensive quarries have been opened in this sandstone, and when carefully selected it is a tolerably good building stone. At some of the quarries the rock is partly concretionary, the concretions in some cases being from six to eight feet in diameter, and exceedingly hard. Other beds of sandstone appear in local outcrops at various points in the county, and furnish some material suitable for cellar walls, etc., but are of only local value.

Limestone for Lime.—The best material for lime burning is to be obtained from the upper bed of limestone on Sugar creek, north of Virden, where a lime kiln was formerly located. The bed at this point is from ten to twelve feet in thickness, the upper part being nodular and fragmentary, and the lower part even bedded in layers from four to twelve inches thick. The upper part would furnish an excellent macadamizing material for common roads, fit for immediate use.

Ochre and Iron Ore.—On Mr. David Miller's farm, four miles south east of Springfield, in a cut on the Springfield and South-eastern railroad, a bed of brown ochre was exposed about fifteen feet below the surface. It proved to be of good quality, and was used by him in painting some portions of his dwelling house, but appeared to be only a local deposit of no great extent. It probably originated, like the common bog ores, from ferruginous springs, and like them it is only a local development.

Sand and Clay.—These materials are abundant, the loess clays and sub soil furnishing them over nearly all the uplands in the county, and excellent cherry brick can be manufactured abundantly in every neighborhood in the county.

Soil and Agriculture.—This county ranks among the very best in Centrel Illinois as an agricultural region. Its surface is largely composed of broad stretches of nearly level, or gently rolling prairies, separated by considerable belts of excellent timber along the streams. There is but little broken land in the county, and that is mostly confined to the bluffs of the Sangamon, along its lower course in this county. East of Howlett, the bluffs are comparatively low, and slope gradually up to the level of the adjacent prairie. The soil upon the prairie is a rick black loam, highly productive, and yields annually large crops of corn and all the cereals adapted to the climate. It is, however, most decidedly a corn producing and stock growing region, and these are the principal agricultural products of this county.

PALÆONTOLOGY.

DESCRIPTIONS OF

INVERTEBRATES FROM CARBONIFEROUS SYSTEM,

BY F. B. MEEK AND A. H. WORTHEN.

PREFATORY NOTE.

At the time the plates for this volume were prepared, it was intended that the descriptions we had already published in the Proceedings of the Philadelphia Academy of Natural Science should be thoroughly revised before publication in this report, and that all the species, especially of crinoids, already described by others, and now illustrated from far better specimens than those originally studied by the authors of the species, should also be thoroughly described and their affinities discussed; but owing to the unfortunate illness of Mr. MEEK, I have been deprived of his assistance in thus preparing the whole for the press, and my own time being otherwise employed, we have been compelled to depart from the original design, and to republish many of the descriptions without revision.

A. H. WORTHEN.

LOWER CARBONIFEROUS SPECIES.

FOSSILS OF THE BURLINGTON GROUP.

ECHINODERMATA.

NOTES ON THE STRUCTURE AND HABITS OF THE PALÆOZOIC CRINOIDEA.

BY F. B. MEEK AND A. H. WORTHEN.

(Proceedings Acad. Nat. Science, Philadelphia, 1868, p. 323, et. seq.)

Through the kindness of Mr. CHARLES WACHSMUTH, of Burlington, Iowa, we have recently had an opportunity to examine some unique and exceedingly interesting specimens of Carboniferous Crinoids, showing parts of the structure of these animals, in some instances, never before observed, so far as we are at this time informed. In a few instances, these specimens show internal organs entirely free from the matrix, and although, like all the other solid parts of these curious creatures, composed of numerous calcareous pieces, really surpassing in delicacy of structure the finest lace-work, and so frail that a touch, or even a breath, might almost destroy them. Some of these specimens we propose to notice here, but, before proceeding to do so, we avail ourselves of this opportunity to express our thanks to Mr. WACHSMUTH for the zeal, industry, skill and intelligence he has brought to bear, in collecting and preparing for study, such an unrivaled series of the beautiful fossil Crinoidea of this wonderfully rich locality. Some idea of the extent of his collection of these precious relics may be formed, when we state that of the single family *Actinocrinidæ* alone, after making due allowance for probable synonyms, he must have specimens of near 150 species, or perhaps more, and many of them showing the body, arms and column.

It is also due to Mr. WACHSMUTH, that we should state here that he is not a mere collector only, but that he understands what he collects, and knows just what to collect, as well as how to collect.

Below we give substantially some notes of observations made in his collection, followed by some remarks on other specimens at Springfield:

1. *Synbathocrinus*, Phillips. Some of Mr. WACHSMUTH's specimens of a species of this genus show that it is provided with a long, slender, pipe-stem like ventral tube or proboscis, apparently equaling the arms in length. Also, that a double row of minute alternating marginal pieces extends up within the ambulacral furrows of the arms, apparently all their length. We are not aware that these characters have been hitherto noticed in any of the publications on this genus. It will be seen, however, farther on, that minute marginal pieces probably occupied the furrows along the inner side of the arms of other types of Crinoidea, as well as this.

2. *Goniasteroidocrinus*, Lyon and Casseday. Some unusually fine specimens of the typical species of this genus (*G. tuberosus*) in Mr. WACHSMUTH's collection, from Crawfordsville, Indiana, show the slender pendent arms much more distinctly than any we had before seen, and from these it seems evident that these arms are stouter than we had supposed, and that there are not more than five or six of them to each of the ten openings. In the specimen figured by us on page 220 of the second volume of the Illinois reports, these arms were only imperfectly seen by working away, with great difficulty, the hard matrix between two of the produced rays of the vault, which we have termed pseudobrachial appendages, or false arms. In clearing away the matrix of this specimen, we had cut just far enough to expose the edges of the arms on each side of the deep ambulacral furrow, so that each of these edges presents the appearance of being a separate and distinct, very slender arm, composed of a single series of pieces, and without any ambulacral furrow on the outer or ventral side; whereas there is a well-defined ambulacral furrow, bearing the tentacula along its margins, on the outer side of the arms, and when the matrix is removed from these ambulacral furrows, the arms can be seen to be composed each of a double series of small alternately-arranged pieces. It is barely possible that in specimens of this species with the arms *perfectly preserved*, that the ambulacral furrows may be covered on the outer or ventral side by a double series of alternating pieces, and that the tentacula* may connect

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* We use the term tentacula here in the sense it is generally used by Palæontologists, with reference to the delicate pinnulæ along the arms of Crinoids, and of course not as applying to the minute fleshy organs along the ambulacral furrows, usually termed tentacles by those who have investigated the recent Crinoids.

with little openings along each side, though there certainly *appear* to be only open furrows in the specimens examined.

It is worthy of note, in this connection, that there certainly are species, agreeing exactly in all other known characters with this genus, that have no open furrow along the outer or ventral side of the arms, which are distinctly seen to be round on the outer side, and show there a double series of interlocking pieces along their entire length, while the tentacula connect along the inner or under side, as the arms are seen hanging down. This is clearly seen to be the case in a beautiful specimen of *G. typus* (=*Trematocrinus typus*, Hall) in Mr. WACHSMUTH's collection, and we can scarcely doubt that in this species there is an open furrow on the inner (under) or dorsal side of the arms. If not, the arms must be tubular, in consequence of having the ambulacral canal enclosed all around, excepting at the points where the tentacula connect along each side.

3. *Cyathocrinus*, Miller. Specimens of this genus showing the vault (more properly the ventral disc) have very rarely been seen. In England a few examples have been found, and these have been supposed to show two openings, one central and another lateral; the latter, according to Prof. PHILIPPS' and Mr. AUSTIN's figures, being provided with a slender marginal tube, or so-called proboscis. Some of Mr. WACHSMUTH's specimens, however, of *C. malvaceus* and *C. Iowensis*, Hall, showing the vault, have led us to doubt the existence of a central opening in the vault of this genus, when the specimens have this part entire. The specimen of *C. malvaceus* shows the remains of the usual narrow lateral proboscis, and also has an opening in the middle of the vault, but from the appearance of this opening, as well as from the structure of the vault of a specimen of *C. Iowensis*, in which this opening is closed, we can scarcely doubt that it was also closed in the specimen of *C. malvaceus*, when entire. † The remaining parts of the vault of the *C. malvaceus* mentioned consist of only five comparatively large pieces, alternating with the upper inner edges of the first radial pieces—the one on the anal side being larger than the others, and forming the base of the inner side of the proboscis. These five pieces connect with each other laterally, and extend inward some distance, but not so far as to meet at the center, where there is a sub-semicircular opening, nearly as large as that in the remaining base of the proboscis. Along each of the sutures between the five vault pieces mentioned, a comparatively large furrow extends inward from each arm-base to the central opening. These we regard as continuations of the ambulacral furrows from the arms, though there is also a minute opening at each arm-base, passing

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† See plate 9, fig. 14.

directly downward into the cavity of the body, which was probably for the passage of the arm-muscles.

Looking at this specimen alone, one would naturally suppose there must have been, during the life of the animal, two distinct openings in the vault, as appears to be the case in the specimen of *C. planus*, Miller, figured by Professor PHILLIPS and Mr. AUSTIN. But on examining the specimen of *C. Iowensis* mentioned above, we find that it shows the base of the small lateral proboscis, with the five principal vault-pieces alternating with the first radials (the one on the anal side being larger than the others), and the same ambulacral furrows extending inwards from the arm-bases, all exactly as in the *C. malvaceus*. But here we find the central opening undoubtedly closed by several vault pieces, while the ambulacral furrows, extending inward from the arm-bases, pass in under these central pieces, and are themselves occupied, or covered, by a double series of alternating, very minute pieces, which probably also extend on all the way up the ambulacral furrows of the arms as marginal pieces.*

From our examinations of these two specimens, which are the only examples of the genus we have seen, showing the vault pieces, and seem to be typical forms of the genus in all other respects, we are strongly inclined to think the specimen of *C. planus*, figured by Prof. PHILLIPS and Mr. AUSTIN, has had these central vault pieces removed by some accident. The fact that these pieces in the specimen examined by us, in Mr. WACHSMUTH'S collection, seem not to be deeply implanted between the five larger surrounding pieces mentioned, but rather rest, as it were, partly upon the narrow bevelled points of the inner ends of the latter, between the ambulacral furrows, so as to allow room for these furrows to pass under, would render them less firm, and more liable to be removed by any accident, and may possibly account for their absence in the English specimen mentioned.

In regard to the pieces covering the central part of the vault, and which, from the way they are arranged for the ambulacral furrows to pass under them, were apparently more liable to be removed than the others, we would remark that they do not present the prominent appearance and uniformity of size and form of the movable pieces composing what is often called the ovarian pyramid in the Cystids, but certainly have all the appearances of true fixed vault pieces, and scarcely project above the others surrounding them. Consequently we cannot believe it at all probable that this genus had a central mouth, opening directly through the vault, though its ambulacral canals evidently converged from the arm-bases to the middle of the vault, partly above the outer vault pieces, and under those composing the middle of the vault. That these furrows terminated at the entrance of the alimentary canal, under the middle of the vault, as those of *Comatula* converge to the mouth, in the same central position, is highly probable; and, as will be seen further on, we are much inclined to believe that the minute organisms upon which we are led, from analogy, to think these animals subsisted, were conveyed to the entrance of the alimentary canal along the ambulacral furrows, without the agency of any proper mouth, opening directly through the vault. Hence we think it probable that the small tube, usually called the proboscis, situated near the posterior side of the ventral disc, rather corresponds to the tubular anal opening similarly situated in *Comatula Mediterranea.*

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* See plate 9, fig. 13.

From our description of the vault of these species, it will be seen to present considerable similarity to that of *Crotalocrinus rugosus*, excepting that in that genus, owing to its great number of arms, the ambulacral furrows, or canals bifurcate several times between the middle of the vault and the arm-bases, while in *Crotalocrinus* there is no lateral proboscis, nor, apparently, even any visible opening, judging by the figures we have seen, though we suspect it may have a small opening at the periphery of the ventral disc, on the posterior or anal side. In the group of depressed *Platycrini* for which TROOST proposed the name *Cupellæcrinus* we observe a somewhat similar vault, at least in some of the species; also in *Coccocrinus.* In such forms there would seem to be, as it were, an intermediate gradation between the modern Crinoids and the prevailing Palæozoic types, as has been pointed out by Mr. BILLINGS.

4. *Convoluted support of the digestive sack, in the Actinocrinidæ.*—The presence of a large convoluted body, resembling in form the shell of a *Bulla* or *Scaphander*, within the body of several types of the *Actinocrinidæ*, was noticed by Prof. HALL, in Vol. XLI, p. 261, of the Am. Jour. Sci., in 1866, though he made no suggestions there in regard to the functions it probably performed in the internal economy of these animals. In the second volume of the Illinois Geological Reports, published soon after, we figured on page 191, a specimen of *Strotocrinus*, with this body seen in place, and stated that we regarded it as having been connected with the digestive apparatus of the animal.

Both in Prof. HALL'S and our own remarks, this organ was spoken of as a convoluted *plate.* This, however, we now know is not strictly correct; for, although composed of hard calcareous matter, and in some species somewhat dense in structure, it seems to be always constructed of a great number of minute pieces, and generally has a more or less open or porous texture; while in some cases it presents the appearance of an exceedingly delicate net-work. It seems never to be attached to the bottom of the visceral cavity, though it extends down nearly to the bottom. It is open at both ends (the opening at the lower end being generally smaller than the other), and is placed with its longer axis nearly so as to coincide with that of the body of the Crinoid. In some species it is more or less dilated at the upper end, while in others it is contracted at both ends, so as to present, as above stated, the form of the shell of a *Bulla*. It has apparently no columella, but is more or less loosely convoluted, with a spiral ridge descending the interior, and sometimes another ascending the exterior. Its walls are generally of moderate thickness, but they often appear to be thicker than natural, in consequence of the presence of inorganic incrustations of calcareous or silicious matter, which also disguise its real structure.

In *Batocrinus Verneuilianus*, † Shumard, this body is narrow below, and sub-cylindrical above to the top, which is slightly dilated. The small opening at the lower end has a thickened rim, which passes around spirally, so as to ascend the outside, as a rather stout ridge, all the way to the top, making nearly two turns, and apparently also forming a rim partly around the top. The surface of the whole organ, as well as of its external spiral ridge, has the usual rough appearance, and when fragments of it are held up, so as to be examined by transmitted light, through a good pocket-glass, it is seen to be composed of a great number of very minute polygonal pieces, varying somewhat in form and size. When these pieces are examined under a magnifier, by reflected light, they show shining facets, like crystals, though they are evidently not surface incrustations, but actually compose the walls, or substance of the organ itself. No pores or meshes were observed passing through the walls of this organ in this species, in which it appears to be more than usually dense.

In another specimen in Mr. WACHSMUTH'S collection, apparently of *Actinocrinus proboscidialis*, * this organ, as seen with one or more of the outer turns removed, has an oval or subelliptic form, being contracted and twisted at both ends, so as to present very nearly the appearance of the shell of some species of *Ovulum*. Its walls are quite thin, and seem to form more convolutions than in any other species in which we have had an opportunity to examine it. As seen by the aid of a magnifier by transmitted light, it presents a very beautiful appearance, being composed of a great number of minute pieces, with numerous openings passing through between them. The little pieces and the openings between them are of nearly uniform size, and arranged so that there are usually one or two of the former intervening between any two of the openings.

Another of Mr. WACHSMUTH'S specimens of *Actinocrinus securis*, Hall, has one side of the body removed so as to show about two-thirds of the convoluted organ, the upper part of which is broken away. The part remaining has a short, wide, sub-cylindrical form, with a rather broad, obliquely truncated lower end, which is not tapering, as in the other species. Under a magnifier it is seen to be composed of an extremely fine net-work, far surpassing, indeed, in delicacy of structure, the finest laces that it is perhaps within the power of human skill to fabricate; and as it is entirely free from any surrounding matrix, except at one side below, the specimen has to be handled with great care, as a mere touch of this delicate part would probably cause it to fall into hundreds of minute fragments. On examining it under a magnifier, the little bars of which it is composed are seen not to intersect each other at any uniform angle, but anastomose, so as to impart a kind of irregular regularity, if we may so speak, to the form and size of the meshes. Of these little bars there are two sizes, the larger forming the larger meshes, while within the latter a smaller set of processes extend partly or entirely across, so as to form more minute meshes; the whole presenting a beautiful appearance, of which it would be difficult to convey a correct idea by a mere description alone, without the the aid of figures.

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* See plate 9, fig. 7 † See plate 9, fig. 12.

From analogy, judging from what is known of the internal structure of the recent genus *Comatula*, in which several authors have noticed a reticulated calcareous structure secreted within the tissue of the softer parts of its alimentary canal, we may infer that this convoluted organ was, as it were, a kind of frame work, secreted for the support of the digestive sack, which was probably more or less convoluted in the same way in many, if not all of the Palæozoic Crinoids, though not apparently, in all cases, endowed with the power of secreting a sufficient dense structure of this kind to leave traces of its existence in a fossil state.

So far as we are at this time informed, this organ has yet been very rarely observed in any other family than the *Actinocrinidæ*, though it was probably more or less developed in various other groups. In one instance Mr. Wachsmuth found it in a *Platycrinus*, but here it seems to be, in the specimen found, merely a spongy mass, not showing very clearly the convoluted structure. Some traces of what was supposed to be something of this kind were also observed by him in one of the Blastoids.

5. *Ambulacral canals passing under the vault in the Actinocrinidæ.* In the third and fourth Decades of descriptions and illustrations of the Canadian Organic Remains, Mr. Billings, the able palæontologist of the geological survey of the Canadian provinces, gives some highly interesting and instructive remarks on the ambulacral and other openings of the Palæozoic Crinoids. In these remarks he noticed at length some striking differences between the vault, or ventral disc, of these

older types, and that of the few living examples of this extensive order of animals. That is he noticed the facts that while in the living *Comatula* and *Pentacrinus,* the ambulacral canals are seen extending from the arm-bases across the surface of the soft skin-like ventral disc, to the central mouth, and these genera are provided with a separate anal opening, situated excentrically between the mouth and the posterior side, that in the Palæozoic Crinoids the ventral disc is very generally, if not always, covered by close-fitting, solid plates, showing no external traces whatever of ambulacral furrows extending inward from the arm-bases; and that in nearly all cases they are merely provided with a single excentric, or subcentral opening, often produced into a long tube which, like the vault, is made up of solid plates. He showed that there is no evidence whatever that the ambulacral canals in these older types were continued along the surface of the vault from the arm-bases to the only opening, whether subcentrally or laterally situated, and that in cases where this opening is produced in the form of a greatly elongated proboscis, or tube, such an arrangement of the ambulacra would be almost a physical impossibility. Hence he concluded that the ambulacral canals must have passed directly through the walls of the body at the arm-bases; and he gave several figures of various types, showing openings at the base of the arms, through which he maintained that the ambulacra must have passed to the interior of the body from the arms.

Although these arm openings had long been well known to all familiar with our numerous types of western Carboniferous Crinoids, in which they are very conspicuous, and we had never entertained any other opinion in regard to them, than that they are the only passages of communication that could have existed between the softer parts occupying the ambulacral furrows of the arms, and the interior of the body, Mr. BILLINGS was the first author, so far as we are at this time aware, who called especial attention to them in this regard. We regret that we have not space to quote a portion, at least, of his remarks on this subject, and would advise the student to read attentively the whole of both of his articles alluded to.

The specimens at Mr. BILLINGS' command enabled him to trace the courses of the ambulacral canals from the arms, through the walls of the body at the arm-bases, and to ascertain the additional fact that, after passing through the walls, they seemed to have turned upward; but beyond this he had not the means of tracing them.

A single specimen of *Actinocrinus proboscidialis,** however, in Mr. WACHSMUTH'S collection is in a condition (thanks to the great skill of that gentleman, and the exceedingly fortunate state of preservation, by which its delicate internal parts remain almost entire, and without any surrounding matrix,) to throw much additional light on the subject. By very dextrous manipulation, Mr. WACHSMUTH succeeded in removing about half of its vault, so as to expose the internal parts, in place, and in an excellent state of preservation. The convoluted organ already described in other species is in this comparatively large, subcylindrical in the middle, apparently tapering at the lower end, and a little dilated at the upper extremity. It seems to be rather dense, and shows the usual rough appearance, but as we had no opportunity to examine any detached fragments of it by transmitted light, we did not determine whether or not it has pores passing through it, though it probably has, at least when entirely free from any inorganic incrustation. Its slightly dilated upper end seems to stand with its middle almost, but apparently not exactly, under the middle of the nearly central proboscis of the vault; while at the anterior side of its upper margin, and a little out from under the proboscis, it shows remains of a kind of thickened collar, which we found to be composed of minute calcareous pieces. From this there radiate five ambulacra, composed of the same kind of minute pieces as the collar itself, each ambulacrum consisting of two rows of these minute pieces alternately arranged. They are each also provided with a distinct furrow along their entire length above. As they radiate and descend from their connection with the top of the convoluted frame-work of the digestive sack, they all bifurcate, so as to send a branch to each arm opening, those passing to the posterior rays curving a little at first above, so as not to pass directly under the proboscis. These amulacra, although passing along obscure furrows in the under side of the vault, which are deepest near the arm openings, are not in *contact* with the vault, or visibly connected with any other parts than the top of the convoluted digestive sack, and the outer walls at the arm openings. Each of their subdivisions can be traced into an arm opening, and it is very probable that they continued on out the ambulacral furrows of the arms and tentacula. At one point in one of these ambulacral canals, beneath the vault, some evidences of the remains of two rows of minute pieces were observed, alternating with the upper edges of those composing the under side of these canals, and thus apparently covering them over. The condition of the parts is such, however, as scarcely to warrant the assertion that this was really the case, though we are much inclined to think it was. If so, these canals must have been, at least under the vault, hollow tubes, formed of two rows of pieces below, and two above, all alternately arranged.

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*Plate 9, Fig. 8.

We are not aware that any evidences of the existence of these delicate ambulacral canals, composed of minute calcareous pieces, and passing beneath the vault from the arm openings to the summit of the convoluted digestive sack, have ever before been observed in any Crinoid, recent or extinct; and we can but think it probable, that the extremely rare combination of circumstances that brought them to light in this instance may not again occur for centuries to come, with regard to another specimen. That they correspond to the ambulacral canals seen extending from the arm-base to the mouth, on the outside of the ventral disc in *Comatula*, is clearly evident.

The presence of furrows radiating from the central region of the under side of the vault to the arm openings, in various types of Palæozoic Crinoids, must have been frequently observed by all who have had an opportunity to examine the inner surface of this part. Messrs. DE KONINCK and LEHON figure a portion of the vault of *Actinocrinus stellaris*, in their valuable *Recherches sur les Crinoides du Terr. Carb. de la Belgique*, pl. 3, fig. 4 f., showing these furrows, which they seem to have regarded as the impressions left by the muscles of the viscera. The inner surface of the vault of most of our western Carboniferous Crinoids is known to have these furrows more or less defined, either from specimens showing this inner surface, or from natural casts of the same. In some instances they are very strongly defined from the central region outward to the arm bases, to each of which they send a branch. In *Actinocrinus ornatus*, Hall, for instance, they are generally so strongly defined as to raise the thin vault into strong radiating ridges, separated by deep furrows on the outer side. In *Strotocrinus*, the vault of which is greatly expanded laterally, and often flat on the top, these internal furrows, in radiating outward, soon become separated by partitions, and as they go on bifurcating, to send a branch to each arm, they actually assume the character of rounded tubular canals, some distance before they reach the arm-bases.

That these furrows or passages of the inner side of the vault were actually occupied during the life of the animal by the ambulacral canals as they radiate from the top of the convoluted digestive sack to the arm openings, we think no one will for a moment question, after examining Mr. WACHSMUTH's specimen of *Actinocrinus proboscidialis*,* which we have described, showing all these parts in place. It is also worthy of note that in all the specimens of various types in which these furrows of the under side of the vault are well known, whether from detached vaults or from casts of the interior of the same, they *never converge directly to the opening of the vault, but to a point on the anterior side of it*, whether there is a simple opening or a produced proboscis. The point to which they converge, even in types with a decidedly lateral opening of the vault, is always central or nearly so, and even when the opening is nearly or quite central, the furrows seem to go, as it were, out of their way to avoid it, those coming from the posterior rays passing around on each side of it to the point of convergence of the others, a little in advance of the opening. That the ambulacral canals here, under this point of convergence of the furrows in the under side of the vault, always came together and connected with the upper end of the convoluted frame work of the digestive sack, we can scarcely entertain a doubt.

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* See Pl. 9, Figs. 7, 9 and 10.

Now in looking at one of these specimens, especially an internal cast of the vault, showing the furrows (or casts of them) starting from a central, or nearly central point, and radiating and bifurcating so as to send a branch to each arm-base, while the opening or proboscis of the vault (or the protuberance representing it in the cast) is seen to occupy a position somewhere on a line between this central point from which the furrows radiate and the posterior side, one can scarcely avoid being struck with the fact that this point of convergence of the ambulacra, under the vault, bears the same relations in position to the opening of the vault, that the *mouth* of a *Comatula* does to its *anal* opening. And when we remember that eminent authorities, who have dissected specimens of the existing genus *Comatula*, maintain that these animals subsisted on microscopic organisms floating in the sea water, such as the *Diatomaceæ*, minute *Entomostraca*, etc.,* which were conveyed to the mouth along the ambulacral canals, perhaps by means of cilia, we are led from analogy to think that the Palæozoic Crinoids subsisted upon similar food, conveyed in the same way to the entrance of the digestive sack. If so, where would there have been any absolute *necessity* for a mouth or other opening directly *through* the vault, when, as we know, the ambulacral canals were so highly developed *under* it from the arm openings to the entrance into the top of the alimentary canal? Indeed, it seems at least probable that if the soft ventral disc of *Comatula* had possessed the power of secreting solid vault pieces, as in most types of Palæozoic Crinoids, that these vault pieces would not only have covered over the ambulacral furrows, as in the palæozoic types, but that they would also have hermetically covered over the mouth, and converted the little flexible anal tube into a solid calcareous pipe, such as that we often call the proboscis in the extinct Crinoids.

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* BRONN mentions the fact (Klassen des Thierreichs. Actinozoa, II, p. 211,) that the remains of *Diatomaceæ*, of the genera *Navicula*, *Actinocyclus* *Coscinodiscus*, and of Entomostraca, were found in the stomach of *Comatula*, and suggests that when such objects in floating in the sea water came in contact with the ambulacral furrows or the pinnulæ, they were conveyed along these furrows to those of the arms, and thence in the same way into the mouth. He ridicules the idea, sometimes suggested, that the food may have been handed by the pinnulæ or arms directly to the mouth.

DUJARDIN and HUPE also state (Hist. Nat. des Zoophytes Echind., p. 18,) that the living *Comatula* was "nourished by microscopic *Algæ* and floating corpuscles, which the vibratile cilia of the ambulacra brought to the mouth." That they may have sometimes swallowed a larger object that accidentally floated into the mouth, however, is not improbable, and would not, if such were the case, by any means disprove the generally accepted opinion that these animals received their food almost entirely through the agency of their ambulacral canals.

From all the facts, therefore, now known on this point, we are led to make the inquiry: whether or not, in all the Palæozoic Crinoids in which there is but a single opening in the vault—whether it is a simple aperture, or prolonged into a proboscis, and placed posterally, subcentrally, or at some point on a line between the middle and the posterior side—this opening was not, instead of being the mouth, or both mouth and anus, as supposed by some, really the anal aperture alone; and whether in these types the mouth was not generally, if not always, hermetically closed by immovable vault pieces, so far as regards any direct opening through the vault?

We are aware of the fact that at least one apparently strong objection may be urged against this suggestion, and in favor of the conclusion that the single opening seen in these older Crinoids was the mouth, or at least performed the double office of both anal and oral aperture. That is, the frequent occurrence of specimens of these palæozoic species, with the shell of a *Platyceras* in close contact by its aperture, either with the side or the vault of the Crinoid, and not unfrequently actually covering the only opening in the vault of the latter, so as to have led to the opinion that the Crinoid was in the very act of devouring the Mollusk at the moment when it perished.

Amongst the numerous beautiful specimens of Crinoids found in the Keokuk division of the Lower Carboniferous series at Crawfordsville, Indiana, there is one species of *Platycrinus (P. hemisphæricus)*, that is so abundant that probably not less than two hundred, and possibly more, individual specimens of it have been found there by the different collectors who have visited that noted locality; and, judging from those we have seen, apparently about one half of these were found with a moderate sized, nearly straight, or very slightly arched and conical *Platyceras (P. infundibulum)*, attached to one side by its aperture, between the arms of the Crinoid and often so as to cover the single lateral opening in the vault of the same.* From the direction of the slight curve of the apex of the *Platyceras*, it is also evident that it is always placed in such a manner, with relation to the Crinoid, that the anterior side of the Mollusk was directed upward, when the vault of the Crinoid was turned in that direction.* A species of *Goniasteroidocrinus* (*G. tuberosus*, Lyon and Casseday), found at the same locality, also has frequently a *Platyceras* attached to the top of its nearly flat vault, so as to cover the only opening in the same. It is worthy of note, however, that it is always another, subspiral, *Platyceras* (very similar to *P. æquilaterum*), that we find attached to this Crinoid, so that here at least, it would seem that each of these two Crinoids has its own particular species of *Platyceras*.

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* We at one time thought these shells attached to the side of this *Platycrinus*, to be out of reach of the opening, or supposed mouth, because we had not seen specimens showing the position of the opening in this species, and had supposed, from its similarity to *Platycrinus granulatus*, Miller, and other species without a lateral opening, that such was also the case with this. We have since seen specimens, however, showing that it has a lateral opening, and therefore belongs to the group *Pleurocrinus;* so that it is probable these shells often cover this opening. See Pl. 16, Fig. 6, *a. b. c.*

In all of these, and numerous other examples that might be mentioned, it is worthy of note, that it is to species of Crinoids with a simple opening in the vault, and not to any of those with a produced proboscis, that we find these shells attached in this way,† and it is so rarely that we find shells of any other genus than *Platyceras*, apparently attached to, or in contact with, the body of a Crinoid, that it seems probable where other shells are occasionally so found, that their connection with the Crinoid may be merely accidental. If it could be established as a fact, that these Crinoids were actually devouring these Mollusks, by sucking out, or otherwise extracting and swallowing their softer parts, in any instance where they have been found with a shell attached over the opening of the vault, this would, of course, establish the fact that this opening is the mouth, or, at least, that it must have performed the office of both oral and anal aperature. But to say nothing in regard to all that is known of the habits and food of the recent Crinoids being so directly opposed to such a conclusion, the fact that so large a proportion as nearly one-half of all the individuals of some species should have died at the precise moment of time when they were devouring a *Platyceras*, and should have been imbedded in the sediment and subsequently fossilized without separating from the shell, seems, to say the least of it, very improbable.

And it is even more difficult to understand upon what principle an animal with its viscera incased in a hard unyielding shell, composed of thick, close-fitting calcareous pieces, and with even its digestive sack, as we have reason to believe, at least to some extent, similarly constructed, could have exerted such powers of suction as to be able to draw out and swallow, through an aperture in its own shell, often less than one-tenth of an inch in diameter, the softer parts of a mollusk nearly or quite equal in volume to the whole of its own visceral cavity. That they ever did so, however, becomes still more improbable, when we bear in mind the fact, that the animal supposed to have performed this feat, lived, at least during the whole of its adult life, attached to one spot by a flexible stem, that only allowed it a radius of a foot or so of area to seek its prey in; while the mollusk it is supposed to have so frequently devoured, from its close affinities to the genus *Capulus*, may be supposed to have almost certainly lived most of its life attached to one spot.‡ In such a case, why should the Crinoid have so frequently left the *Platyceras* to grow within its reach to nearly its adult size before devouring it? But if from some unknown cause it should have done so, by what means could the Crinoid have pulled loose the Mollusk (which from analogy we may reasonably suppose held with some degree of tenacity to its place of attachment), and placed it with the aperture of its shell over the opening supposed to be its mouth? That it could have used its arms and tentacula as prehensile organs, in this sense, is extremely improbable from their very structure, so much so indeed that few if any of the best authorities who have investigated the recent Crinoids, believe that they ever used these apendages to hand directly to the mouth, even minute organisms.*

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* Prof. RICHARD OWEN has noticed, in his Report on the Geological Survey of Indiana, p. 364 (1862), the frequent occurrence of a *Platyceras* attached to this same *Platycrinus*, at this locality, and proposed to name the *Platyceras P. pabulocrinus*, from the supposition that it formed the chief food of these Crinoids. It is probable that the *Platyceras* for which he proposed this name, is the same we named *P. infundibulum*, but as he gave no description of the species, and but an imperfect figure, we cannot speak *positively* as to its identity. Prof. HALL has also proposed the name *P. subrectum* for this Crawfordsville *Platyceras*, but he had previously used the same name for a very different, New York, Devonian species of this genus.

Prof. YANDELL and Dr. SHUMARD have also figured, in their paper entitled "Contributions to the Geology of Kentucky," a specimen of *Acrocrinus*, with a very similar *Platyceras* apparently attached to its vault.

Amongst all the numerous Crinoids found at Burlington, Iowa, we are aware of but a single instance of one being found with a *Platyceras* attached, and that is a specimen of *Actinocrinus ventricosus* in Mr. WACHSMUTH's collection, which has a crushed shell of a *Platyceras* connected with its vault.

† Possibly due to the fact, that in species with a proboscis there is much less room for attachment to the vault.

But we believe the strongest argument against the conclusion that the Crinoids, so frequently found with the shell of a *Platyceras* attached to them, died while in the act of sucking out, or otherwise extracting the softer parts of these Mollusks, remains to be stated. In the first place, if such really was the nature of the relations between the Crinoid and the Mollusk, it is of course self-evident that the continuation of the life of the latter must have necessarily been of very short duration after it came in contact with the Crinoid. Yet we have the most conclusive evidence that such was not the case; but on the contrary, in most if not all of these instances, the *Platyceras must have lived long enough in contact with the Crinoid to have adapted the sinuosities of the margins of its shell exactly to the irregularities of the surface of the Crinoid.*

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‡ Most of the best European authorities on paleontology refer these shells even to the existing genus *Capulus*.

* In many instances it is clearly evident that it would have been an *absolute impossibility* for certain types of our Carboniferous Crinoids to have handed any object, great or small, directly to the only opening through the vault. That is, where this opening is at the extremity of a straight rigid tube, often nearly twice the length of the arms, even to the extreme ends of their ultimate divisions. We are aware that some have supposed this tube, or proboscis, to have been flexible, and the Messrs. AUSTIN even thought it was especially designed and used for the purpose of sucking out the softer parts of Polyps. If flexible, we might suppose that in those cases where it was so much longer than the arms, that it could have been curved so as to bring its extremity within reach of the ends of the arms; but although we have in a few instances seen this tube more or less bent, a careful examination always showed that, where this was not due to an accidental fracture after the death of the animal, it was caused by the plates composing it being on one side larger, or differently formed from those on the other, and evidently not to flexibility. We find the arms, which were evidently flexible, folded and bent in every conceivable manner, but the tube of the vault is, in nine cases out of ten, if not more frequently, when not accidentally distorted, found to be perfectly straight, or a little inclined to one side or the other.

We have taken some trouble to examine carefully a number of specimens of *Platycrinus hemisphæricus*, and *Goniasteroidocrinus tuberosus*, from Crawfordsville, Indiana, with each a *Platyceras* attached, and in all cases where the specimens are not too much crushed or distorted, or the hard argillaceous shaly matter too firmly adherent to prevent the line of contact between the shell and the Crinoid to be clearly seen, the sinuosities of the lip of the former closely conform to the irregular nodose surface of the latter. Owing to the fact that in some cases the shell has evidently been forced by accidental pressure against the surface of the Crinoid, so as to become somewhat crushed, this adaptation is not always so clearly evident; but in most cases it is more or less visible, while in some it is strikingly manifest. In one instance of a *Platycrinus* now before us, with a *Platyceras* attached, as usual, to its side, between the arm-bases of two of its adjacent rays, and of rather larger size than those usually found attached to this species, the adaptation of the irregularities of its lip, so as to receive the little nodes and other prominences of the Crinoid, is so clearly manifest that a moment's examination must satisfy any one that the shell must have grown there. Being, as we stated, a larger individual than we usually see so situated, it not only occupied the whole of the interradial or anal space to which it is attached, but its lateral margins on each side coming in contact with the arm-bases of the Crinoid, as the shell increased in size, had formed on either side *a profound sinus in its lip for the reception of these arms.* These sinuses are not only in precisely the *proper places*, but of exactly the *proper size and form* to receive the adjacent arm on each side, the entire adjustment being so exact that it seems scarcely possible that the shell could have been removed during the life of both animals, and after the Mollusk had attained its present size, without either breaking its lip or breaking off the arms of the Crinoid. Unfortunately, in clearing away the rather hard argillaceous matrix, before the arrangement of the parts was clearly comprehended, these arms were broken away, but their stumps are still seen protruding from the sinuses, which are so deep as almost to present the appearance of isolated perforations, though it is evident, on a careful examination, that they are only deep emarginations extending up from the edge of the lip.

In looking at the sides of this *Platyceras*, which has the form of a very slightly arched cone,* and stands out nearly at right angles to the side of the Crinoid, it is easy to see, from abrupt curves in the lines of growth along up its sides, on a line above the sinuses mentioned, that these sinuses commenced forming abruptly at points about half way up; and on measuring across between these points with a pair of dividers, the space between is found to coincide very closely with that between the inner sides of the arm-bases protruding from the sinuses. Hence it is evident that the shell had commenced forming these sinuses in its lip exactly at the period of its growth when it had attained a breadth that brought the edges of its lip in contact with the arm-bases. After this it had increased very little *in breadth* between the arms of the Crinoid, though it had grown somewhat wider above and below, and *nearly doubled its length.* Whether or not it covers the opening in the side of the vault of the Crinoid we are unable to say, since the folded arms (which are, as usual in these cases, well preserved) and adhering matrix cover the vault. We have scarcely any doubt now, however, that the *Platyceras* does in this, as in most of the other cases, actually cover the opening in the side of the vault of the Crinoid.

From the facts stated it is, we think, evident that these Mollusks actually lived long enough after their connection with the Crinoids, to which we find them attached, not only to have adapted the edges of their lips to fit the surface of the Crinoid, but to have generally increased more or less in size, and in some instances at least to have actually nearly or quite doubled their size. Admitting this to be the case—and we think there can be no reasonable doubt on this point—we can no longer believe that these Crinoids were preying upon the Mollusks, and we therefore think no well grounded arguments can be based upon the fact of their being so frequently found attached in the manner described in favor of the conclusion that the opening in the vault of these Crinoids is the mouth.

But, if they were not in the habit of eating these Mollusks, it may be asked what could have been the nature of the relations between the two that so frequently brought them together as we now find them? The first explanation that suggests itself is, that possibly the Mollusk may have been preying upon the Crinoid. But the fact, already stated, that these Mollusks evidently lived long enough attached to these Crinoids, as we have every reason to believe, during the life of the latter, to have at least increased the size of their shells considerably, if not indeed during their entire growth, is alone an almost insurmountable objection to such a conclusion. Doubtless, like other marine sedentary animals, these Mollusks, when very young, floated freely about in the sea until they found a suitable station to attach themselves, where they remained during life. May they not, therefore, have been attracted to the bodies of Crinoids by the numerous little organisms brought in by the action of cilia, along the ambulacral furrows of the arms of the Crinoids, or in currents produced by the motions of the arms of the latter? The excrementitious matter of the Crinoid could doubtless have passed out under the foot of the *Platyceras*, supposing the opening in the Crinoid sometimes covered by these shells to have been the anus; but it is difficult to conceive how food could have passed in, if we suppose this opening to be the mouth.

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* It being the common species of *Platyceras* that is usually found attached to this *Platycrinus*.

GENUS ACTINOCRINITES, Miller.

(Proceed. Acad, Nat. Sci., Philad., 1869, p. 153.)

In the second volume of the Illinois reports, published in 1866, after admitting as distinct genera from *Actinocrinites* the groups *Megistocrinus*, *Agaricocrinus*, *Amphoracrinus* and some others, we also separated under the name *Strotocrinus* a group of remarkable American Carboniferous species, of which *Actinocrinus perumbrosus*, Hall, was regarded as the type. At the same time that we made this separation there were amongst the collections before us specimens of another allied type, in regard to the proper disposition of which we were in considerable doubt. These belong to the group of which *A. ventricosus*, Hall, may be regarded as an example. We readily observed that while in some of their characters they agree most nearly with *Strotocrinus*, that in others they seemed to be more closely allied to *Actinocrinites*, and at one time we were very much inclined to the opinion that a strictly systematic definition of all the different genera of the *Crinoidea* would require their separation as a distinct intermediate genus. Wishing to avoid disturbing the existing nomenclature, however, as much as possible, we finally concluded to place this group provisionally as a section under *Actinocrinites*.

Since that time we have had an opportunity to study an extensive series of these and the allied groups, in Mr. WACHSMUTH'S collection, and have been led to the conclusion that if this type does not form a separate genus, holding an intermediate position between *Strotocrinus* and *Actinocrinites*, that it should be placed as a distinct sub-genus under the former. Adopting this view, and admitting, as we have elsewhere done, that the *Batocrinus* and *Dorycrinus* groups should stand as distinct genera, the genus *Actinocrinites* would be left to include two sections; * that is, the typical forms, such as Miller's *A. triacontadac-*

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* There are doubtless other sections, but we allude here to the forms we have had an opportunity to study.

tylus and *A. polydactylus*, and de Koninck's *A. stellaris*, *A. diversus*, *A. deornatus* and *A. armatus*, with various others; and the group including *A. multibrachiatus* and its allies.

The typical forms of *Actinocrinites*, which agree almost exactly with all the other genera mentioned, as well as with the *A. multibrachiatus* group, in the number and arrangement of the pieces composing the walls of the body below the bifurcations of the rays, are distinguished by the following characters, never found all combined in any one of the other groups:

In the first place, they have the arm bases, or brachial pieces, and adjacent parts (sometimes as far in as the third primary radials) grouped together so as to form five more or less protuberant lobes,* and so far as yet known to us, at least a part of the arms bifurcating *after* becoming free, and always each composed of a single series of pieces below each bifurcation, as well as generally for some little distance above. They also combine with these characters a more or less produced central or sub central tube or proboscis, and have the second primary radial pieces nearly always normally hexagonal.

The other group represented by *A. multibrachiatus* differs from the typical forms of *Actinocrinites* in having the arm bases arranged in a nearly or quite continuous series all around, and the arms *never* bifurcating *after* becoming free, as well as in nearly always having normally the same number of arms in each ray. The species of this group also more generally have the vault higher in proportion to the body below the arms, but there are a few exceptions to this in both groups. In a few species of typical *Actinocrinites* the arm bases are less distinctly grouped, and not so protuberant as in others, but so far as we have yet seen they can readily be distinguised by the structure and bifurcations of their arms, where specimens retaining them can be seen, and nearly always, even where the arms are broken away, by their wider interradial and anal sinuses and other peculiarities of general physiognomy, apparent enough to the eye but difficult to express in words.

In having the arm bases arranged in a nearly or quite continuous series all around, and the arms never bifurcating after becoming free, the *A. multibrachiatus* group agrees with *Batocrinus*, but it differs from that group in having longer arms in proportion to the length of the proboscis, which in *Batocrinus*, when entire, protrudes from one-fourth to

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*Since these remarks were in type, we observe, on consulting Miller's Nat. Hist. of the *Crinoidea*, to which we had not previously had access for many years past, that he seems to have confounded two very distinct forms under the one name of his typical species, *Actinocrinites triacontadactylus*. One of these, *if correctly represented on Plate I of his work*, must belong to an entirely different species from that figured under the same name on his Plate II, as it is represented as having its arm bases and contiguous parts, not forming five widely separated protuberant lobes, but arranged more like those in the American section represented by such forms as *A. multibrachiatus*, though its arms clearly bifurcate *after* becoming free.

one-half its entire length beyond the extreme length of the arms.* They also differ from *Batocrinus* and agree with *Actinocrinites* in nearly always (perhaps always normally) having the second radial pieces hexagonal instead of quadrangular, while their body plates are more or less sculptured (generally strongly so) into radiating costæ, usually consisting of a single rib for each side of each plate, instead of having the plates even and smooth, merely convex or tumid. In short, the species of these two groups can be distinguished at a glance from specimens even showing the body only.†

As thus limited, the genus *Actinocrinites* would include, along with a number of foreign species, the following American Carboniferous forms.‡

1. ACTINOCRINITES, Miller. *Section* (*a*).

A. verrucosus (=*A. asterius*, McC.), *A. chloris* (=*A. tenuisculptus*, McC.), *A. lobatus*, *A. Humboldtianus*, *A. jugosus*, *A. pernodosus*, *A. unicostatus*, *A. Lowei*, *A. brontes*, etc., of Hall. Also, *A. Yandelli* and *A. multiradiatus*, Shumard; *A. Wachsmuthi*, White; and *A. scitulus*, M. and W. (=*A. rusticus*, Hall, and *A. Sillimani*, M. and W.); as well as our *A. penicillus* and *A. delicatus* of this paper, and *A. Indianensis*, L. and C., with perhaps several others with which we are not very well acquainted.§

2. *Section* (*b*).

A. multibrachiatus, *A. proboscidialis*,‖ *A. cœlatus*, *A. clarus*, *A. limabrachiatus*, *A. ovatus*, *A. securus*, *A. opusculus*, *A. excerptus*, *A. infrequens*, *A. thalia*, *A. thetis*, *A. thoas*, *A. locellus*, *A. sexarmatus*, *A. reticulatus*, all described under *Actinocrinus* by Prof. Hall. Also, *A. Fosteri* and *A. Hurdianus*, McChesney, and our *A. longus* of this paper.

It is worthy of note that all the known Burlington species of this group came from the Lower Burlington beds, as has been determined by Mr. WACHSMUTH, by careful observations continued through many years.

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* See figs. 1 and 2, plate 11, Iowa Geo'l Report, Vol. I, part ii.

† See plate x, fig. 10, Iowa Geo'l Report. Vol. I, part ii. For other examples of this group see figs. 13 and 14 same plate, where they may be compared with figs. 7 and 9 of the same plate, representing two species of true *Actinocrinites*, with arm bases grouped into five protuberant lobes.

‡ There are some other described American species not mentioned in this list, which is only intended to include such species as we have had an opportunity to study.

§ Dr. Shumard's *A. concinnus* belongs here, if not a *Steganocrinus*. We have not yet seen a specimen of it showing the rays far enough out to decide positively to which of these groups it belongs.

‖ *A. quaternarius*, *A. quaternarius var. spiniferus* and *A. Themis*, Hall, are believed to be varieties of his *A. proboscidialis*.

ACTINOCRINITES. *Section (a).*

ACTINOCRINITES PENICILLUS, M. and W.

Pl. 8, fig. 2*

Actinocrinus penicillus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 155.

BODY small, inversely campanulate, or with sides expanding rapidly from the truncated base to the secondary radials, which with the brachial pieces curve a little outward. Base much depressed, or about four times as wide as high, broadly truncated, and but slightly concave below; margin more or less expanded horizontally, and deeply notched at the sutures. First radial plates comparatively rather large, and about twice as wide as high. Second radials near half as large as the first, about twice as wide as high. Third radials a little larger than the second, wider than long, and pentagonal in form, the lateral margins being short, each supporting on each of its superior sloping sides a secondary radial of about its own size, which in its turn supports two free arms.

Anal pieces unknown above the second range; first one smaller (particularly narrower) than the first radials, and supporting two others of its own size in the next range. Interradial pieces three to five in each space; first one as large as the second radials, hexagonal in form, and bearing upon its upper sloping sides two smaller pieces, above which there is generally one or two minute pieces.

Arms free from their origin on the secondary radials, and composed below of slender rounded pieces, the first of which is about twice as long as wide, and more or less constricted in the middle; beyond this the lateral arm on each side of each ray is simple, with its second piece like the first, and followed by two or three other shorter wedge-formed pieces, before passing into a double series of small, alternately arranged pieces. Inner arms of each ray bifurcating on the first piece, and one of the subdivisions in one or both bifurcating again on the first piece, thus making from seven to eight arms to each ray, or from thirty-five to forty in the entire series. The single piece below and the first above each division is slender, rounded, and more or less constricted, and generally two or three wedge-formed pieces follow the latter before the commencement of the double series of alternating pieces, above which the arms are a little wider and of moderate length; vault unknown; proboscis very slender at the upper end, and apparently of about the same length as the arms.

Surface of all the body plates deeply excavated at the corners, and prominent in the middle, the prominence of the first radials usually forming a transverse ridge, from which a single more or less defined vertical ridge ascends the second radials to the middle of the third, from which it bifurcates and continues to the secondary radials.

Hight of body to the top of secondary radials, about 0.22 inch; breadth at the top of secondary radials, 0.40 inch; length of arms, if straightened out, about 0.70 inch; breadth of same, at the widest part near the middle, 0.05 inch.

This little species is allied to *A. lucina*, Hall, which, before seeing specimens showing the arms, we had supposed to belong to the *A. multibrachiatus* group, but which is a true *Actinocrinites*. Our species differs, however, in having the arms more frequently and differently bifurcating, so as to make from thirteen to fifteen more in the entire series. Its arms also differ in not being subspinous on their margins.

Locality and position—Lower Burlington beds of Lower Carboniferous, Burlington, Iowa. No. 38 of Mr. WACHSMUTH'S collection.

ACTINOCRINUS SCULPTUS, Hall.

Pl. 4, fig. 2.

Actinocrinus sculptus, Hall, 1858. Geol. Sur. of Iowa, Vol. I, part 2, p. 582. Burlington limestone, Burlington, Iowa.

ACTINOCRINITES DELICATUS, M. and W.

Pl. 8, Fig. 2.

Actinocrinites delicatus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 155.

BODY small, subturbinate, or widening rather rapidly from the somewhat truncated base to the top of the third radials. Base depressed, or about four or five times as wide as high, with slightly expanded margins notched at the sutures. First radial pieces of moderate size, a little wider than long, and as usual, two heptagonal and three hexagonal. Second radial pieces a little smaller than the first, more or less regularly hexagonal, the superior lateral sides, however, being sometimes very short. Third radials about as large as the second, normally pentagonal, but sometimes with the lateral angles truncated so as to give them an irregular heptagonal outline. Secondary radials resting one upon each superior sloping side of each third primary radial, which they exceed in length; more or less prominent, curving outward, and generally constricted and rounded in the middle, though not entirely free from the walls of the body, excepting on the upper side; supporting on each of their superior (free) sloping sides the first divisions of the arms. First interradial pieces about as large as the first radials, hexagonal, and supporting two smaller pieces in the next range, which connect with others above, belonging apparently more properly to the vault. First anal piece nearly as large as the first radials, heptagonal in form, and supporting in the second range two pieces, one of which (in the typical specimen) is as large as the first; above these there are four or five smaller irregular pieces in the third range, and above the latter others belonging apparently to the vault.

Arms slender, rounded, and composed below of distinctly constricted pieces longer than wide, and after the first division on the secondary radials the inner ones bifurcating on the second piece, and one or both of these subdivisions divide again on the second piece, above which they still continue to be composed of a single range of rounded pieces for a short distance, and then pass gradually through a few wedge-formed pieces into a double series of alternating pieces; above this they are all a little stouter than below, and show a very slight tendency to become somewhat flatter toward their upper extremities. So far as can be seen, the two outer arms of each ray are simple from their origin on the secondary radials, and composed of a single series of rounded and constricted pieces as far up as the last bifurcations of the other arms; consequently there appear to be eight ultimate divisions, or arms, to each ray. (Vault unknown.)

Surface apparently minutely granular, and with a small, more or less defined ridge extending from the base up the primary radials to the third radial, on which it bifurcates and sends a branch to the base of each of the two main arms. On the first radials, as well as the anals, there is also some tendency to send off an obscure ridge across from one to another, on each side. None of the body plates are tumid, though they are generally very slightly convex.

Hight of body from bottom of base to the top of secondary radials, 0.16; breadth, about 0.30 inch.

This species is related to *A. chloris*, Hall, but is much smaller, and differs in having its body, below the arms, merely rather rapidly expanding, with nearly straight sides, instead of being hemispherical. Its arms also bifurcate differently. In the *chloris*, for instance, they all (or at any rate the inner ones), after their origin on the secondary radials, bifurcate once on the first piece beyond, while in our species the inner arms bifurcate on the second piece, and the outer of those subdivisions again on the second piece.

Locality and position—Upper division of the Burlington member of the Lower Carboniferous, at Burlington, Iowa. Mr. WACHSMUTH'S collection.

ACTINOCRINITES. *Section (b.)*

ACTINOCRINITES LONGUS, M. and W.

Pl. 8, fig. 1.

Actinocrinites longus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 156.

BODY rather elongate-obconic below the arms, the sides expanding gradually, with a moderately convex outline from the base to the tertiary radial pieces, which, with the brachial pieces, curve very slightly outward. Base about twice and a half as wide as high, not thickened or expanded below, and but very slightly notched at the sutures; facet for the reception of the column large and moderately concave, with a rather large central perforation. First radials comparatively large, very nearly or quite as long as wide. Second radials scarcely half as large as the first, about as wide as long, quadrangular, pentagonal, or unequally six-sided. Third radials of about the same size as the second, pentagonal, hexagonal, or heptagonal, and each bearing on its superior sloping sides two secondary radials of near its own size, each of which supports on its outer sloping upper side, brachial pieces, leading to an arm, and on its inner side, above, a small tertiary radial giving origin to two arms, thus making three arms to each main division, and six to each ray, or thirty to the entire series. (Arms unknown.)

Anal plates five or six, the first being of the same size as the smaller first radials, hexagonal in form, and a little longer than wide; second anals two, about two-thirds as large as the first, and irregularly heptagonal or octagonal; above these there are two smaller pieces in the third range, and one or two still smaller pieces above the latter, the upper one being barely large enough to separate the posterior lateral brachial pieces of the two posterior rays. First interradial pieces about half as large as the first radials, heptagonal, and supporting two smaller pieces in the second range, above which there are one or two still smaller pieces in the third, and a minute piece over the latter, wedged in between the brachial pieces. In each interaxillary space there are usually two intercalated pieces, the lower of which is sometimes as large as one of the tertiary radials, while the upper is very small, and wedged in between the brachial pieces.

Vault conical, and nearly three-fourths as high as the body below the arms, composed of irregular pieces of moderate size, some of which project in the form of small pointed nodes or short spines, passing gradually into a rather large subcentral proboscis.

Surface of all the body plates rather distinctly convex, but not properly tumid, and showing but the faintest traces of an effort to form, on some of the smaller pieces, an obscure radiating ridge near each side. In most cases, however, these are entirely obsolete, and the plate seems to be merely evenly convex.

Hight of body to arm bases, 1.20 inch; breadth of same at arm bases, 1.40 inch; hight of vault, about 0.80 inch.

In the structure of its body, as well as in its arm formula, this species agrees with *Actinocrinus clavis*, of Hall. It differs, however, greatly in form, as well as in the surface characters of its body plates, being rather elongate obconical below the arms, instead of "very broadly subturbinated, and spreading more rapidly above the third radial plates;" while its body plates are merely convex, instead of being "elevated into strong angular nodes, some sometimes marked by low ridges on the lower part," and by "strong angular ridges" on the upper part.

Its elevated conical vault, passing gradually into the nearly central proboscis, and narrow obconic body below the arms, give it a peculiar fusiform outline. In the nature of its vault it resembles quite nearly *A. costatus*, of Hall, from which, however, it differs widely in other respects.

Locality and position—Lower beds, Burlington group of Lower Carboniferous, Burlington, Iowa. Mr. WACHSMUTH'S collection.

GENUS STROTOCRINUS, M. and W. 1866.*

(Proceed. Acad. Nat. Sci., Phila., 1869, p 158.)

Extending the genus *Strotocrinus* so as to include, as already suggested, the *Act. ventricosus* group as a subgenus, we will have, first, the typical urn-shaped species, such as *S. perumbrosus and S. liratus*, with the structure of *Actinocrinites* up to the divisions of the rays, but with the body comparatively long and narrow below, and the secondary and other succeeding supplementary radials, brachial and intermediate pieces, connected laterally all around, and spreading out horizontally far beyond the limits of the body, so as to form, with the flat or much

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* Second Vol. Illinois Report, p. 188, 1866.

depressed vault, a broad, more or less distinctly ten-angled disc, from the margins of which the numerous long, slender arms arise, without bifurcating after becoming free.† Indeed, with rare exceptions, the rays can scarcely be said to bifurcate, properly, after the division on the third primary radials, though each main division continues on out, throwing off alternately on each side brachial pieces in close contact with each other, until, at last, it terminates in a single free arm. Each of the arms commences abruptly as a double series of small alternating pieces immediately on the last fixed brachial piece, without an intermediate series of free single pieces extending entirely across. Some of the species, such as *S. perumbrosus*, have but a very small simple opening situated subcentrally, or more or less excentrically towards the anal side, and penetrating the flattened vault obliquely, so as to be directed forward or away from the anal side; while others, like *S. liratus*, have a long erect, subcentral tube, or so-called proboscis, sometimes recurved at the end. The column is known, at least in the species provided with proboscis, to be peculiar in being composed of very thin segments, a part of which, at regular intervals, project out beyond the others, and send up and down, at equal distances all around, five external, thickened processes or ribs, apparently as a natural provision to give it strength, without destroying its flexibility.

Then we have the *Act. ventricosus* group, which not only agrees with the *S. perumbrosus* section of *Strotocrinus* in having merely a very small subcentral or excentric opening in the vault, without any traces of a proboscis, but also, to a considerable extent, in the manner in which the subdivisions of the rays are given off; but differs in having these subdivisions not in contact so as to form a disc, but divided by narrow interradial, anal, axillary, and sometimes interbrachial sinuses, the former of which often extend quite into the body. The species of this group also differ from the typical forms of *Strotocrinus* in having the body shorter below the arms, and the vault generally more ventricose, and provided with external furrows radiating from the middle to the anal and interradial sinuses. So far as yet known, the species of this type have rather stouter and less numerous arms than we see in *Strotocrinus* proper, but generally more than we see in *Actinocrinites*. In both groups of *Strotocrinus* the arms are, as in *Actinocrinites*, provided with numerous pinnulæ, or so-called tentacles, but here they seem to be always armed with minute spines directed more or less obliquely upward from the upper margins.

From *Actinocrinites* the *A. ventricosus* group not only differs in being without any traces of a proboscis, but in having its ventricose, furrowed vault composed of numerous minute pieces; and the divisions of its rays, although not forming a continuous disc as in *Strotocrinus* proper, not grouped into five lobes. Its arms also differ in never bifurcating after becoming free. For this group we propose the name *Physetocrinus* (φυσητὸς, puffed up; κρίνον, a lily, in allusion to the ventricose vault of the typical species, *Act. ventricosus*, Hall.)[‡]

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† Some of the species have as many as seventy to eighty arms.

The genus *Strotocrinus*, as here defined, would include the following species, all peculiar to the lower Carboniferous rocks of America:

1.—STROTOCRINUS, M. and W. (proper).

Section (*a*). Species without a proboscis.—*S. perumbrosus*,[*] *S. regalis* and *S. glyptus*, all described under *Actinocrinus* by Prof. HALL.

Section (*b*). Species with a proboscis.—*S. ægilops*, *S. rudis*, *S. liratus*, *S. umbrosus*,[†] *S. tenuiradiatus*, *S. tholus* and *S. insculptus*, all described by Prof. HALL under *Actinocrinus*. It may also probably include his *Act. glans*. His *A. clavis* is believed to be synonymous with his *S. ægilops* (sp.) and his *Act. subumbrosus* a variety of his *S. liratus* (sp.)

2.—Subgenus PHYSETOCRINUS, M. and W.

P. ventricosus, *P. cancellatus*, *P. ornatus* and *P. reticulatus*, all described by Prof. HALL under *Actinocrinus*; also *P. subventricosus*, described by Prof. MCCHESNEY under *Actinocrinus*. The proposed species *senarius*, Hall, is believed to be a variety of his *A. ornatus*.

In the single character of having only a simple opening in the vault, without the slightest indications of a proboscis, the *Physetocrinus* group would agree more nearly with the typical section (a) of *Strotocrinus* than the section (b) does, but in all other characters it is more distinct.

STROTOCRINUS? ASPERRIMUS, M. and W.

Pl. 8, Fig 3,

Strotocrinus asperrimus? MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 160.

BODY under medium size, urn-shaped, being a little wider at the top of the third radials than high, with the secondary radials and succeeding parts spreading out horizontally, but divided by narrow anal and interradial sinuses quite into the body; sides ascending with a gradual expansion to the top of the third radials, with a moderately convex outline below the middle. Base about twice and a half as wide as high, not thickened or spreading below, but projecting downward a little around the column, in the form of little nodes, formed by deep notches at the sutures and smaller ones between. First radials generally wider than long. Second radial pieces somewhat smaller than the first, wider than long, some hexagonal and others pentagonal. Third radials a little smaller than the second, generally pentagonal and bearing on each superior sloping side a secondary radial, each of which supports one or more brachial pieces, leading to an arm on its outer sloping side, and a small tertiary radial on its inner, each of which evidently supported two other pieces above, one or both of which were probably brachials. If both sides bore brachials it would make six arms to the ray, but if one side bore an auxillary piece it would make eight to the ray, or forty to the whole series.

[‡] Iowa Geological Report, Vol. 1, part 2, Palæont., pl. 11, fig. 6, a b.

[*] See Vol. II, Geological Report Illinois, p. 188, 1866.

[†] Iowa Report, part 11, pl. ii, fig. 3, a b.

First anal piece of about the same size as the smaller first radials, slightly longer than wide, hexagonal in form, and succeeded by two smaller hexagonal or heptagonal pieces in the second range, above which there seems to be about four other smaller pieces. Subradials three or four to an area, the first one about as large as the second radials, hexagonal or heptagonal in form, and supporting two smaller pieces in the next range; above this there seems to be one, or possibly sometimes two other smaller pieces. Auxillary spaces sometimes occupied by one or two small pieces.

Vault much depressed, or rising little above the horizon of the arms, composed of irregular small and moderate sized pieces, and provided with a nearly central proboscis, which in the typical specimen is composed of very small pieces at the base, and a little inclined to one side.

Surface of body plates all prominent and angular in the middle, and provided with well defined, sharp radiating costæ, which are compound on the first radial and first anal pieces, but generally consist of a single rib, extending from the middle to each of the sides of the others. The mesial prominence on each of the first and second radials is pinched out so as to form a prominent sharp, transversely arranged ridge, while on each of the smaller plates it is a rounded, rather pointed node, the whole presenting a very rough appearance.

Hight of body to the horizon of the arms, 0.74 inch; do. to top of vault, 0.88 inch; greatest breadth at top of third radials, 0.80 inch.

In general form and surface markings this species resembles the following, but its body is more spreading above, and it has ten or more arms less, while its vault is much more depressed and provided with a proboscis. It seems to bear much the same relations to the section (b) of the genus *Strotocrinus* that the subgenus *Physetocrinus* bears to the typical forms of *Strotocrinus*.

Locality and position—Burlington Limestone of the Lower Carboniferous, at Quincy, Illinois.

SUBGENUS PHYSETOCRINUS, M. and W.

STROTOCRINUS (PHYSETOCRINUS?) ASPER, M. and W.

Pl. 7, Fig. 1.

Strotocrinus (Physetocrinus?) asper, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 181.

BODY somewhat urn-shaped, being obconical below, with nearly straight, gradually expanding sides, and rather ventricose vault. Base about three times as wide as high, truncated below and angular, though not thickened or properly expanded around the lower margin, which is so broadly and deeply notched at the sutures as to present a trilobate appearance as seen from beneath. First radials wider than high, and as usual two heptagonal and three hexagonal. Third radials of the same size as the second, and bearing on each of their superior sloping sides a somewhat smaller secondary radial, each of which bears on its outer sloping side a series of brachial pieces, leading to an arm, while on its inner sloping side it supports a small tertiary radial, bearing on its inner side brachial pieces leading to an arm, and on its outer a small quaternary radial, bearing on its outer side a brachial piece, and on its inner another auxillary piece, giving origin to two arms, thus making, as far as can be determined, ten arms to each ray, or fifty to the entire series.

First anal piece as long as the first radials, but narrower, heptagonal in form, and supporting one small piece over its middle and a larger one on each upper sloping side in the second range; in the third range there are three, in the fourth two pieces, and above these three smaller pieces extending up so as to connect with the vault. First interradial pieces of about the size of the third radials, hexagonal in form, and bearing two smaller pieces in the second range, above which there are some five or six very small, irregular pieces, some of the upper of which extend up and connect with the vault.

Vault rather ventricose, or more than one-third as high, near the middle, as the body below the horizon of the arms; composed of irregular, nearly flat pieces, of moderate size; opening apparently simple, at the highest point about one-third of the distance from the middle towards the posterior side.

All the body plates are protuberant and sharply angular in the middle, the angular part, especially on the larger plates, forming a sharp transverse ridge. From the under side of this transverse ridge two or three others extend downward on the first radial and first anal pieces, so as to connect with others on the basal pieces. The second and third radial pieces have each about three small pointed nodes, arranged transversely, while from the third radials narrow ridges extend up to the secondary radials, thence up all the branches to each arm-base. All the smaller body plates also have a more or less projecting angular point in the middle.

Notwithstanding the number of arms, the narrow anal and interradial sinuses extend in so as to divide the disc quite in to the body, while even the interbrachial sinuses extend nearly in to the body. The column is of moderate thickness near the base, where it is round and composed of thin pieces with sharp projecting edges, pierced by a nearly round central canal.

Hight to horizon of arms, 0.73 inch; breadth across at the interradial sinuses, 0.90 inch; hight of vault, 0.46 inch.

This species has its plates sculptured in nearly the same way, and presenting much the same roughened appearance seen in *S. glyptus*, Hall (sp.), but it differs materially from that and all of the other species known to us, that resemble it in other respects, in having deep interradial and anal sinuses in its disc, as in the subgenus *Physetocrinus*, with which it also appears to agree in its ventricose vault. It is the only species known to us, however, apparently belonging to that group that has its body so narrow and produced below, and its body plates presenting this style of angular sculpturing. If the interradial and anal sinuses of its disc were filled with intercalated pieces it would present nearly all the characters of a typical *Strotocrinus*. Consequently, it may be regarded as a connecting link between these groups, and with a few others shows that they cannot be properly separated more than subgenerically.

Locality and position—Upper beds Burlington group of Lower Carboniferous, at Burlington, Iowa. No. 67 of Mr. WACHSMUTH'S collection.

Section (*b*).

STROTOCRINUS ECTYPUS, M. and W.

Pl. 7, fig. 5.

Strotocrinus ectypus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 159.

BODY depressed, very rapidly expanding to the third radials, above which the secondary and tertiary radials and brachial pieces curve out horizontally. Base about twice and a-half as wide as high, truncated, slightly concave, and not expanded or thickened below, but with small nodes around the margin of the under side, placed one at the termination of each of the costæ. First radial pieces wider than high, two heptagonal and three hexagonal. Second radials one-half to two-thirds as large as the first, wider than high, hexagonal, or in part (sometimes) pentagonal, the superior lateral sides being short. Third radials wider than long, pentagonal, hexagonal, or irregularly heptagonal, and supporting on each superior sloping side a secondary radial, each of which gives origin to brachial pieces leading to an arm on the outer side, and supports on its inner sloping side a tertiary radial, which gives origin to two arms, thus making three arms to each main division, or six to each ray, and thirty to the entire series.

First anal piece a little longer than wide, hexagonal, and supporting two pieces of about half its own size in the next range; between the superior sloping inner sides of these there is one small piece, and above these three or four other small pieces, one or two of which extend up so as to separate slightly the outer brachial pieces of the adjacent rays. Interradial pieces, four or five to each area, the upper of which is narrow and extends up so as to separate slightly the brachial pieces above. In each interaxillary space there is usually an elongated intercalated piece, sometimes large enough to truncate slightly the upper margin of the third primary radial, while it continues upward so as to separate the brachial pieces above.

Vault much depressed, and composed of numerous, irregular, slightly convex pieces of moderate size, and provided with a rather stout sub-central proboscis, composed near the base of unequal pieces, some of which are distinctly protuberant.

Surface of all the body plates moderately convex, or sometimes a little angular in the center, and ornamented with distinct radiating costæ, extending from the middle to the sides of each piece, so as to divide the whole into numerous triangles. These costæ are also more or less compound, so as to form a secondary or (below the middle of the first radials) a tertiary series of smaller, less defined triangles within those formed by the principal costæ.

Hight of body to horizon of arm openings, 0.70 inch; breadth at same, 1.60 inches.

This species resembles in the sculpturing of its body plates *S. glyptus*, Hall (sp.), but has a more depressed body, and is also at once distinguished by having a proboscis, while the *S. glyptus* belongs to the section of the genus with merely a simple opening in the vault. From *S. œgilops* it will readily be distinguished by its shorter, more rapidly expanding body and less numerous arms, as well as by its different sculpturing. Although its brachial pieces are a little separated over the anal, interradial, and axillary spaces, there are no distinct sinuses at these points in the margins of the disc, as the little intercalated pieces separating the brachial pieces at these places extend out as far as the latter, so that when the arms are removed, the outline of the disc presents only an obscurely sub-pentagonal outline.

Locality and position—Lower division, Burlington beds of Lower Carboniferous, at Burlington, Iowa. No. 59 of Mr. WACHSMUTH'S collection.

STROTOCRINUS LIRATUS, Hall, (sp.)

Pl. 7, Fig. 2.

Actinocrinus liratus, HALL. Supplement to Iowa Geological Report. Vol. I, part 2, 1860.
Actinocrinus subumbrosus, HALL. Ib. p. 3, 1860.
Strotocrinus liratus, MEEK and WORTHEN. Illinois Geol. Report, Vol. II, p. 190, 1866.

BODY attaining a large size, urn-shaped, being rather elongate-obconic below the horizon of the arm-bases, and depressed convex above; sides expanding gradually from the base to the top of the secondary radial pieces, and then abruptly curving outward horizontally to the arm-bases. Base nearly twice as wide as high, truncated, and rather deeply excavated below, for the reception of the end of the column, and notched at the sutures so as to present a trilobate appearance. First radial pieces generally a little longer than wide, hexagonal and heptagonal in form. Second radial pieces scarcely more than one-third as large as the first, as wide as long, and all hexagonal. Third radials as large as the second, or sometimes slightly larger, heptagonal or octagonal, and each bearing on its superior sloping sides, two secondary radials, each of which bears on its outer sloping side, a series of about three brachial pieces, the last of which supports an arm, and on the inner sloping side a tertiary radial, giving off on one side a succession of brachial pieces leading to an arm as before, and supporting on the other sloping side a quaternary radial, and so on, until each main division of each ray has thrown off six or seven alternating arms, thus making twelve to fourteen arms to each ray, and sixty to seventy arms to the whole series.

Anal plates, about twelve to fourteen, first anal nearly as large as the first radials on each side of it, longer than wide, and hexagonal in form; above this there are two other smaller pieces in the second range, and three in the third and fourth, with a few very small irregularly arranged pieces above the latter. Interradial plates, nine or ten to each area, first one hexagonal, and bearing two smaller pieces in the second, third and fourth ranges respectively. Arms unknown, vault forming less than one-fourth the entire hight, composed of very unequal, irregularly arranged, more or less tumid pieces. Ventral tube, or so-called proboscis, large, very long, slightly tapering, and composed of small pieces usually wider than long, and more or less angular on the outer side; sometimes (perhaps abnormally) recurved at the extremity.

Surface of body plates ornamented with very distinct, compound, radiating costæ, which unite on the prominent middle of the plates, so as usually to form sharply angular, transverse or arched ridges, the whole presenting a very rough but neatly sculptured appearance.

Hight of a medium-sized specimen to the base of the ventral tube, 0.85 inch; breadth of body just below the expanded summit, 1.15 inches. Length of the ventral tube of a somewhat larger specimen, 4.67 inches to the broken end; breadth of same at base, 0.56 inch; ditto of same at the broken extremity, 0.32 inch.

This species will be readily distinguished from all of the others provided with a ventral tube (so far as yet known) by the peculiar style of the ornamentation of its body plates, its costæ being more numerous, and more distinct than in *S. ægilops*, *S. glyptus* and other similar forms. Whether any of the other species were provided with so long a ventral tube remains to be seen, as the specimens yet known all have this part broken away.

The specimen of the species under consideration, represented by figure 2 *a*, of plate 7, has the body crushed, and the ornamentation of the body plates mainly obliterated by weathering. It also shows some irregularity of the body plates, either due to accidental distortion, or to abnormal development. The structure and ornamentation of the body have, therefore, been described by us from the specimen represented by figure 2 *c*, of the same plate. The other individual is figured to show the greatly developed ventral tube. This tube doubtless possessed some slight degree of flexibility during the life of the animal, but the bend near its broken end seems not to have been due to flexibility, but rather to abnormal development, by which the pieces on one side grew to larger sizes than on the other, as may be seen by figure 2 *b* of the same plate, which represents a side view of the curved point. How much longer this tube may have originally been, it is not possible to determine from the specimens, though it was probably not much longer than now seen, though it is undoubtedly broken at the end. Immediately at the broken end, a few little pieces are seen that look as if they might possibly have, with others, partly closed the end. It is more probable, however, that they belong to a part of the broken end, and have merely been placed in the position they now occupy by accident. Unless the tube tapered very rapidly, or was considerably produced beyond the broken end, the opening would have apparently been rather large.

Locality and position—Upper part of the Burlington division of the Lower Carboniferous series, Burlington, Iowa. No. 49 of Mr. WACHSMUTH'S collection.

STROTOCRINUS PERUMBROSUS, Hall (sp.)

Pl. 8, Fig. 4.

Actinocrinus perumbrosus, HALL. Supplement to Vol. I, Part II, Iowa Report, p. 7.
Strotocrinus perumbrosus, MEEK and WORTHEN. Illinois Geol. Report, Vol. II, p. 189; 1866.

BODY presenting the usual urn-shape characteristic of the typical species of the group, being more or less elongate-obconic below the spreading summit, and nearly flat on top. Base more than twice as wide as high, and truncated below for the reception of a rather large round column, but not expanded or provided with a rim around the lower margin; basal pieces rather large, wider than high, and hexagonal in outline. First radial pieces large, about as wide as long, hexagonal and heptagonal in form. Second radials about half as large as the first, and regularly hexagonal. Third radials of nearly the same size of the second, heptagonal and hexagonal in form, and supporting on each of their superior sloping sides a secondary radial of somewhat smaller size. The latter pieces curve outward, to form with the upper anal and interradial pieces, the commencement of the spreading disc; while each bears on its outer sloping side, in direct succession, a series of three or four large brachial pieces, leading out to the margin of the disc, where the last one supports an arm; and on the inner sloping side there is a tertiary radial, giving origin to a series of brachial pieces, leading to an arm on one side, as before, while on the other sloping side it supports a quaternary radial, and so on, until each primary division has in this way thrown off alternately on each side from five to six, or sometimes seven arms, thus making about twelve or more arms to each of these main divisions, or near twenty-four to each ray, and about one hundred or more arms to the entire series. Arms slender and rising from the margins of the disc.

Anal pieces near thirteen, the first being nearly as large as the adjacent first radials, a little longer than wide, and hexagonal in form; above this there are two smaller hexagonal pieces in the second range and three in the third and fourth, with a few smaller pieces above. Interradials about nine to eleven in each space, the first being rather smaller than the second radials, hexagonal in form, and supporting two smaller pieces in the second range, two in the third, and two in the fourth, with a few irregularly arranged smaller pieces extending up between the lateral brachial pieces of the two adjacent rays. There are also usually, about four small pieces occupying each axillary space of each ray, and often a single range of very small pieces intercalated between the brachials, so as to form, with the latter and the supplementary radial pieces, the under side of the expanded disc.

Vault nearly flat, or slightly convex in the central region, and a little concave toward the lateral margins; composed of numerous small, slightly convex pieces of various forms, those near the middle being larger than the others, which become very small toward the margins. These small pieces continue on out so as to cover each of the two main divisions of each ray, all the way to where they give off the last arms. As these divisions of the rays are produced beyond the general margin of the disc, they give it a distinctly ten angled or rayed appearance, as seen from above or below when the arms are removed.

Opening of the vault very small, nearly central, and directed a little obliquely forward, or away from the anal side; there being generally a more or less defined depression extending a short distance forward from its anterior side.

Surface of plates more or less convex, and ornamented by ridges from the central region to the margins, to connect with those of the adjacent plates. Where these ridges unite on the center of the interradial and anal plates, they generally form nodes or prominences, but on the radial plates they give origin to a transverse mesial ridge. The radial plates have their costæ or ridges compound, or more numerous than those of the other plates; while above the third radials the succeeding secondary, tertiary, and other pieces of the rays, as well as the brachial pieces, have each a single ridge extending along the middle, while the small intermediate pieces are impressed so as to form concavities between the ridges.

Hight of the body of a medium sized specimen 1.63 inches; breadth just below the disc 1.30 inches; breadth of disc, measuring across between the rays, 2.20 inches;

do., to the extremities of the rays, 3.10 inches; diameter of the opening of the vault, 0.10.

This species will be readily distinguished from the other known species of the section of the genus with a simple opening in the vault, by its more expanded disc, greater number of arms, and some of the details of its structure, as well as by the sculpturing of its plates.

Locality and position—Upper bed of the Burlington division of the Lower Carboniferous series, at Burlington, Iowa. No. 47 of Mr. WACHSMUTH's collection.

STROTOCRINUS UMBROSUS, Hall (sp).

Pl. 8, fig. 5.

Actinocrinus umbrosus, HALL. Geol. Report, Iowa, Vol. I, part ii, p. 590, pl. XI, fig. 3 a, b, 1858.
Strotocrinus umbrosus, MEEK and WORTHEN. Illinois Geol. Report, Vol. II, p. 190, 1866.

BODY urn-shaped, being truncato-obconic below the arm-bases, and depressed convex above; sides expanding gradually from the base to a point a little above the third radials, then flaring out abruptly above. Base rather broadly truncated below, about three times as wide as high; basal pieces thick, and separated by such deeply furrowed sutures as to present a trilobate appearance; facet for the attachment of the column a little less than half the greatest breadth of the column. First radial pieces generally a little wider than long, and presenting the usual hexagonal and heptagonal outline. Second radial pieces about half as large as the first, and all normally hexagonal. Third radials of about the same size as the second, and varying from hexagonal to heptagonal; each supporting on its superior sloping sides, two secondary radials of nearly its own size; the latter being axillary pieces, bear on their outer sloping sides a series of two or three brachials, the last one of which gives origin to an arm; while on their inner sloping sides they each support a tertiary radial, giving origin on one of its sloping sides, to a series of brachial pieces leading to an arm as before, and supporting on the other a quaternary radial, and so on, so that each of the main divisions of each ray throws off alternately on each side three (occasionally four on one side) arms, making about twelve arms to each ray, or sixty or more to the whole series.

Anal pieces ten to twelve; the first one nearly as large as the first radials, hexagonal in form, and surmounted in the second range by two smaller pieces, above which there are four in the third range, and over the latter three or four other small pieces are irregularly arranged. Interradial pieces seven to eight to each area, the first being about the same size as the second radials, hexagonal in form, and supporting two smaller pieces in the second range, over which are two others in the third range, and above the latter, some three or four small unequal irregularly arranged pieces may be usually counted. One or two very small pieces are also usually seen in each axillary space.

Arms, as usual in the genus, rising from the margins of the expanded disc, very slender, rather long, and not tapering, excepting near their immediate extremities; composed of very small alternating pieces, each one of which bears a pinnule at its outer extremity. Pinnulæ delicate, long, crowded, and composed of joints apparently three or four times as long as wide, and each bearing on its upper margin a small flattened, triangular process, or short compressed spine, that laps upon the next pinnule above, in such a manner as apparently to have prevented the free expansion of any one pinnule when not accompanied by a simultaneous movement of all the others on the same side of each arm.

Vault depressed convex, composed of small, slightly convex, unequal, irregularly arranged pieces, ventral tube subcentral, being slightly nearest the anal side, slender, and rising abruptly from the vault, which does not slope up to its base.

Surface presenting a more or less rough appearance, owing to the tumid character of the body plates, of which the first radial and first anal pieces are the most prominent. In some instances all the radial pieces project in the form of a prominent transverse node, and the anal and interradials more frequently as rounded nodes. The smaller tertiary and succeeding supplementary radial and brachial pieces are merely convex. Sometimes, there are faint indications of very short ridges at the immediate sutures, between the first radial pieces and the bases, as well as at the sutures between the other primary radials.

Hight of the body of a medium sized specimen to the horizon of its arm bases, 0.90 inch; do. to the top of vault from base, 1.20 inches; breadth of expanded vault, between the rays, 1.40 inches; do., to the extremities of the rays, 1.60 inches.

This species will be distinguished from others yet known of the section provided with a proboscis, by its very tumid or nodose body plates without costæ, by the number of its arms, and more spreading disc, and other details. Although the two divisions of each of its rays project somewhat beyond the margins of the disc, so as to give it a ten-angled outline, as seen from above or below, they are not near so much produced as in the last described species.

The specimens of this species figured and described by Prof. HALL, which are now before us, have lost the arms, though they give a good idea of the structure of its body. The beautiful specimen we have figured, although having its body somewhat crushed, and its base broken away, is interesting as it shows the delicate arms and pinnulæ. We have seen no example of this species with ventral tube, or so-called proboscis, preserved. It was evidently very slender, however, even at its base, and rises very abruptly from the depressed convex vault.

Locality and position—Upper bed of Burlington division of the Lower Carboniferous series. The specimen figured No. 50 of Mr. WACHSMUTH'S collection.

STROTOCRINUS (PHYSETOCRINUS) DILATATUS, M. and W.

Pl. 10, Fig. 6.

Strotocrinus (*Physetocrinus*) *dilatatus*, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 162.

BODY rapidly expanding, with nearly straight sides, from the base to the secondary radials, thence spreading more abruptly to the brachial pieces, which are directed out nearly horizontally, and so closely crowded all around as to come very nearly, or sometimes quite, in contact over the anal and interradial areas. Base about three times as wide as high, not thickened or expanded below, but provided with a large round perforation. First radial pieces comparatively large, generally wider than high, two heptagonal and three hexagonal. Second radials only about half as large as the first, some of them quadrangular, and others with one or both of the upper lateral angles a little truncated, so as to make them properly pentagonal or hexagonal. Third radials larger than the second, wider than long, pentagonal, hexagonal or heptagonal, and supporting on each superior sloping side a secondary radial, each of which gives origin on its outer side to brachial pieces leading to an arm, while on its inner side a tertiary radial gives origin to two arms in all but the two posterior rays, where one or sometimes both bear on one side another axillary piece, making seven or eight arms in each of these rays, or, in the latter cases, thirty-four arms to the entire series.

First anal piece as large as the largest first radial pieces, and bearing above two heptagonal or octagonal pieces of near its own size in the second range, with three smaller pieces in the third range, and two or three minute pieces over these, one of which is wedged in between the brachial pieces above. First interradial pieces generally larger than the second radials, heptagonal or octagonal, and surmounted by two smaller pieces in the second range, over which we usually see one or two small pieces wedged up between the outer brachial pieces of the rays on each side. There is also usually a small interaxillary piece between the secondary radials of each ray, but it seems never large enough to extend down so far as to truncate the upper angle of any of the third primary radials.

Arms stout, increasing a little upward for a distance of two and a half inches (as far as they can be seen in the specimen), each passing directly into a double series of very short pieces, from their origin on the last brachial piece.

Surface of body plates merely finely granular where not worn, slightly convex, with shallow indentations at their corners. Vault unknown.

Hight of body to the top of tertiary radials, 0.75 inch; breadth, about 1.33 inch; breadth of arms two inches above their bases, 0.20 inch.

This species is related to *S. (Physetocr.) subventricosus*, McChesney (sp.), but differs in having its body much more rapidly expanding, and proportionally wider above, while its tertiary and brachial pieces curve much more strongly outward. It also differs in the relative size and form of its second radial pieces, which are proportionally smaller, and generally quadrangular, or only with the upper lateral angles slightly truncated, instead of being larger and regularly hexagonal. Its arms are likewise stouter than those of McChesney's species, judging from the brachial pieces seen in specimens of the latter, while it has one or two arms more in each of the posterior rays. Its surface markings are also different, but this is a very variable character in this group.

Locality and position—Lower beds of the Burlington group. Lower Carboniferous. No. 58 of Mr. WACHSMUTH'S collection.

GENUS BATOCRINUS, Casseday.*

FROM deference to the most generally prevalent opinions of paleontologists, we have elsewhere included *Batocrinus* as a sub-genus under *Actinocrinus*, though we did so with a protest, stating that we were strongly inclined to view it as a distinct genus. Our recent study of Mr. WACHSMUTH'S extensive collections has still more decidedly impressed us with the necessity for separating these groups generically.

As we have in other places stated, the genus *Batocrinus* presents no essential difference from *Actinocrinus* in the number and arrangement of the pieces composing the walls of the body below the arms, nor in the vault and its elongated central or subcentral tube, though its second radial pieces generally differ in being proportionally shorter and quadrangular, instead of hexagonal or pentagonal. One of the most obvious differences, however, consists in the arrangement of the brachial pieces and adjacent parts, which in *Batocrinus* form a nearly or quite continuous series all around, instead of being grouped into five protuberant lobes, separated by more or less wide and deep interradial and anal sinuses. Again, in *Batocrinus* the arms never bifurcate as we often see in *Actinocrinus*, all the divisions of the rays taking place in the walls of the body below the brachial pieces; while the arms, (which in all cases yet known, with one exception, spring singly from each arm-opening), are generally much shorter in proportion to the length of the proboscis, which often projects from one-third to one-half its entire length beyond the extreme ends of the arms. Another difference is to be observed in the surface of the body plates, these pieces never being sculptured or ornamented with radiating costæ, as is often seen in *Actinocrinus*, but merely even, more or less tumid, or tuberculiform. The vault pieces in *Batocrinus* are also generally tuberculiform, or sometimes produced into short spine-like projections; but even where they assume the character of spines they never have the regularity of arrangement, nor do they ever attain the length we often see in *Dorycrinus* and *Amphoracrinus*. The species of *Batocrinus* also present a much greater diversity of form than we see in *Actinocrinus*, since we find amongst them every variety of shape, from globose to turbinate, biturbinate, pyriform, discoid, and even, in some rare aberrant types apparently belonging here, a conical or stelliform outline.

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*Proceedings Acad. Nat. Science. Philadelphia. 1869 p. 350, et. seq.

The species of this genus may be variously grouped to facilitate their study, into sections and subsections, based upon their differences of form, and other more or less marked peculiarities, but for the present we merely propose to give a general list of them, and to notice a few types that we have elsewhere included in this group, but which we are now rather inclined to think may yet be found to be entitled to more prominence than has generally been supposed. These are the forms for which the names *Alloprosallocrinus* (= *Conocrinus*, of Troost's list), and *Eretmocrinus*, Lyon and Casseday, were proposed.

The first of these we only know from specimens consisting of the body without the arms or other parts. Its most striking peculiarity, so far as yet known, consists in its remarkable conical form, the body being nearly or quite flat below the arm-bases, which are at first directed out horizontally, and then curve up; while the vault, which forms the whole visceral cavity, is produced upward in a conical form, so as to pass rather gradually into the central or sub-central tube, or so-called proboscis. This mere peculiarity of form, however, might be of little importance in a group presenting such great differences in this respect; but we observe that the arm-bases in the specimens of this type we have seen are usually stouter and composed of rather wide short pieces, more like those composing the arm-bases of *Agaricocrinus*. From this fact we suspect that this type may present some marked differences in the nature of its arms from the typical *Batocrinus*.

The other group *(Eretmocrinus)* is mainly distinguished by a remarkable flattening of the upper part of the arms, by which they are made to present a very curious paddle-shaped or spatulate outline. In some instances this character is so strongly marked, that the breadth of the arms is not less than six times as great above as below the middle. Below, the arms are, as in other types, usually rounded and slender, but farther up the flattening commences, first, by a slight angularity along each side, with often crenate margins, and increases upward above the middle until they sometimes present a very extraordinary alate appearance. The flattened part, however, is always as distinctly composed of a double series of alternately arranged pieces as that below, and these pieces are not only extended laterally to give breadth to the arms, but have also often as much as twice the diameter, in the direction of the length of the arms, of those further down. The ambulacral furrows, however, do not increase in size with the breadth of the arms, but even seem to be smaller above than below. We have not *seen* tentacula attached along the flattened upper part of the arms, but they probably existed there, as we have observed minute indentations at the inner ends of the flattened pieces, apparently for their attachment. The pieces composing the flattened part of the arms are thicker at their inner ends and thin off to their outer extremities, with slight outward curve, so as often to make the dorsal side of the arms not merely flat, but even slightly concave.

If these were free Crinoids, we might suppose this flattening of the arms a natural provision to adapt them for use as swimming organs, as *Comatula* is known to employ its arms for that purpose; but the species presenting this character have the column as well developed as we see in any of the other types, and were evidently attached to one spot during life. It is not improbable, however, that this peculiarity of the arms may have been a provision for the protection of the ova in the tentacula (pinnulæ), for, when these broad flattened arms were folded together, they must have covered these delicate parts within as if by a coat of mail.

The species presenting the character of arms, described above, agree so closely in other respects with the typical forms of *Batocrinus*, that it is perhaps not always possible to distinguish them from specimens with the arms removed, though they seem generally to have a smaller number of arms, which are also generally longer in proportion, and a rather more excentric ventral tube, or proboscis, which appears also to be more liable to be bent to one side, and is often more or less swollen in the middle and narrow below.

These two groups *(Alloprosallocrinus* and *Eretmocrinus)* should, we think, be at least separated subgenerically from the typical forms of *Batocrinus*, and may even be found to belong properly to distinct genera. We should certainly be disposed to view the *Eretmocrinus* group as a distinct genus, if it were not for the fact that the peculiarity observed in the structure of its arms is subject to considerable variation in the *degree* of its development in the different species, being not very strongly marked in some species, while we also observe some slight tendency to a similar flattening of the upper part of the arms in other types of the *Actinocrinidæ*, such, for instance, as in some species of *Dorycrinus*, and other forms usually referred, in this country, to *Actinocrinus.*

Below we add a list of the species of *Batocrinus*, which, it is worthy of note, are entirely confined to America, and,so far as yet known, nearly, if not entirely, to the lower Carboniferous rocks. We give first the names of the species of true *Batocrinus*, and under separate divisions those of *Eretmocrinus* and *Alloprosallocrinus.* We cannot, however, be *positively* sure, in all cases, in regard to the separation of the species of the subgenus *Eretmocrinus* from those of true *Batocrinus*, where specimens showing the arms are unknown. It will also be seen that, even as restricted by the separation, subgenerically, of *Eretmocrinus* and *Alloprosallocrinus*, the species referred to *Batocrinus* are susceptible of division into two sections, that may be entitled to greater prominence than is apparent from the specimens yet known.

1. BATOCRINUS, Casseday.

Section (a).—Species with arm-openings directed outward. Arms from 20 to 26. *Batocrinus icosidactylus* and *B. irregularis*, Casseday, and *B. formosus*, *B. discoideus*, *B. papillatus*, *B. æqualis*, *B. doris*, *B. læpidus*, *B. turbinatus*, *B. inornatus*, *B. longirostris*, *B. calyculus*, *B. biturbinatus*, *B. similis*, *B. lagunculus*, *B. mundulus*, *B. clavigerus* and *B. planodiscus*, Hall (sp.), all of which were described by Prof. HALL under the name *Actinocrinus.* Also *B. Andrewsianus* and *B. subæqualis*, described by Prof. McCHESNEY under *Actinocrinus.* Likewise our *B. pistillus*, *B. pistilliformis* and *B. quasillus.* Also *B. rotundatus* (=*Actinocrinus*, O. and S.), as well as *B. Christyi** and *B. Konincki*,† described by Dr. SHUMARD under *Actinocrinus.*

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* This is the only species of the whole *Batocrinus* group known to have two arms springing from each arm-opening, and this does not arise from a proper bifurcation, as the two arms rest directly upon the brachial pieces, without imparting to them the character of axillary pieces.

† This species has its arms *slightly* flattened, but not expanded above, showing a gradation towards *Eretmocrinus.*

Section (b).—Species with arm-openings directed upward, and arm-bases usually more in groups than in Section (a). Arms, so far as known, 20.

B. Nashvillæ (=*Actinocr.*, Troost); also *B. laura* and *B. sinuosus* (=*Actinocrinus*, Hall), *B. æquibrachiatus* (=*Actinocrinus*, McChesney), and our *B. asteriscus* and *B. trochiscus*.

2. Subgenus ERETMOCRINUS, Lyon and Casseday.

Species with arms flattened and alate above, and generally numbering from 12 to 20. Proboscis or ventral tube excentric, usually slender below, and sometimes swollen in the middle, and more or less bent to one side. Vault usually depressed. Brachial pieces more or less in groups, separated by interradial and anal sinuses.

Batocrinus (Eretmocrinus) magnificus, Lyon and Casseday, and *B. (Eretmocr.) calyculoides*, *B. (Eretmocr.) remibrachiatus*,* *B. (Eretmocr.) clio*, *B. (Eretmoc.) matuta* and *B. (Eretmocr.) clælia*, Hall (sp), all described under *Actinocrinus* by Prof. Hall. Also *B. (Eretmocr.) Verneuilianus*,† Shumard (sp.) described under *Actinocrinus*.

In all of the above species the arms have been seen, and are known to possess the characters of *Eretmocrinus*. The following species are believed to belong here, from the general appearance of the body vault, proboscis, etc., though their arms have not yet been seen. They all certainly belong to *Batocrinus*, even if not to the group *Eretmocrinus*, viz: *B. corbulus*, *B. carica*, *B. oblatus*, *B. sinuosus* and *B. gemmiformis*, all described by Prof. Hall under *Actinocrinus*. Also *B. urnæformis* and *B. Hageri*, described by Prof. McChesney under *Actinocrinus*. Also our *B. dodecadactylus*.

3. Subgenus ALLOPROSALLOCRINUS, Casseday and Lyon (=*Conocrinus* of Troost's lists.)

Body distinctly conical, being flat below the arm-bases (which are directed outward on a plane with the flattened under side), and produced upward to the central proboscis so as to bring the whole visceral cavity above the arm bases. Branchial pieces stout.

B. (Allopros.) conicus, *B. (Allopros.) depressus*, Lyon and Casseday, described under *Alloprosallocrinus*. Also our *B. (Allopros.) euconus*.

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* Prof. HALL mentioned, in describing this species, that it has the characters of *Eretmocrinus*.

† This species has the arms less distinctly alate than the others, the transition from *Batocrinus* to *Eretmocrinus* being through this and the species *Koninckí*.

BATOCRINUS QUASILLUS, M. and W.

Pl. 5, Fig. 2.

Batocrinus quasillus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 352.

BODY rather depressed, wider than high, nearly as prominent above as below the arm-bases; sides spreading very rapidly from the top of the first radials to the brachial pieces, which are in close contact all around, so as entirely to isolate the anal and interradial pieces from the vault. Base comparatively rather broad, being nearly three times as wide as high, truncated and rather deeply excavated below, so as to overhang the end of the column; somewhat spreading below, with broad, shallow notches at the sutures. First radials nearly twice as wide as high, two heptagonal and three hexagonal, and, like all of the other body plates (excepting the second radials), moderately tumid. Second radials generally very short, and sometimes in part merely transversely linear, or even entirely obsolete, all quadrangular, and flat on the outer side. Third radials small, generally pentagonal, and in all but the two posterior rays supporting on each of its superior sloping sides one, or sometimes two secondary radials, the last of which (where there are more than one) is an axillary piece, and bears in direct succession on each of its superior sloping sides, two brachial pieces, thus making four arms to each of these rays. In each of the posterior rays, however, there are two other bifurcations, that make six arm openings to each of these rays, or twenty-four to the entire series. First anal plate of much the same size and form as the first radials, and supporting in an arching series above three smaller pieces in the second range, while above the latter, one, or perhaps sometimes two smaller pieces connect with the brachials above. First interradials about two-thirds as large as the first radials, and each supporting a smaller piece extending up to the brachials above. Vault composed of tumid, or sometimes rather obtusely pointed pieces, and provided with a subcentral proboscis, which is usually about as broad below as the base.

Hight of the largest specimen to top of vault, about 0.70 inch; greatest breadth (which is at the arm-bases), 0.80 inch; breadth of base, 0.35 inch.

This species seems to be related to our *B. pistillus*, but may be easily distinguished by its much more depressed form, particularly below the arm openings, caused by its much shorter basals, and first and second radial pieces. Its base also differs, in being much more excavated, and not near so expanded below, while its brachial pieces are proportionally stouter and more crowded. Although the whole number of arm openings is the same in these two forms, this arrangement is different, the formula of *B. pistillus* being $\overset{4}{\underset{5-5}{5-5}} = 24$, and that under consideration $\overset{4}{\underset{6-6}{4-4}} = 24$.

Locality and position—Lower division of Burlington beds of Lower Carboniferous, at Burlington, Iowa. No. 14 of Mr. Wachsmuth's collection.

Batocrinus (Eretmocrinus) remibrachiatus, Hall's sp.

Pl. 10, Fig. 5.

Actinocrinus remibrachiatus, Hall, 1861. Descr. new Crinoidea, preliminary note, p. 11.

Burlington limestone, Burlington, Iowa.

Batocrinus Cassedayanus, M. and W.

Pl. 5, Fig 1.

Batocrinus Cassedayanus, Meek and Worthen. Proceed. Acad. Nat. Sci., Phila., 1868, p. 353.

Body rather broad, subturbinate below, or with the vault subglobose, being a little larger below than above the arm-bases. Base short, or about four times as wide as high, a little thickened, and slightly overhanging the end of the column, and more or less notched at the sutures, so as to present a somewhat trilobate appearance. First radial pieces of moderate size, and, like all of the other body plates, rather distinctly tumid, wider than long, two hexagonal and three heptagonal. Second radials about half as large as the first, nearly twice as wide as high, normally quadrangular, but some of them occasionally with one or both of the superior lateral angles a little truncated, so as to present an irregular pentagonal or hexagonal outline. Third radials sometimes a little smaller, and in other rays a little larger than the second; all pentagonal, and (excepting in the anterior and one of the anterior lateral rays of the typical specimen) each supporting on each of its superior sloping sides, in direct succession, two secondary radials generally of near its own size, the upper ones of which are also axillary pieces, and bear on each of their superior sloping sides two brachial pieces in direct succession (the last of which is generally larger than the first), thus making four arms to each of these rays. In the anterior ray, however, the third radial merely bears on each side, above, three brachial pieces in direct succession, and the same is also the case on one side of one of the anterior lateral rays, thus only giving origin to two arm openings in the first, and three in the latter, making seventeen arm openings to the entire series. First anal of the same size and form as the first radials, excepting that it is proportionally a little longer; above this there are three smaller pieces in the second range, three in the third, and two or three in the fourth. First interradials of the same size as the second anals, hexagonal or heptagonal in form, and supporting two smaller pieces in the third range, with two to three or four still smaller pieces above, the upper one of which, like that of the anal series, separates the brachial pieces a little, so as to form a small sinus between the arm-bases belonging to each ray.

Vault slightly ventricose, composed of very irregular, unequal, merely tumid pieces, and provided with a rather stout, nearly central proboscis, which is inclined a little forward in the typical specimen.

The specific name is given in honor of Mr. S. A. CASSEDAY, deceased, the author of the genus *Batocrinus*.

Hight of body to arm-bases, 0.70 inch; do. to base of proboscis, 1.07 inch; greatest breadth (at arm-bases), 1.20 inch.

This species is perhaps most nearly allied to *B. longirostris*, Hall (sp.), and if we suppose the presence of only three arm openings in one of its anterior lateral rays to be abnormal, which is almost certainly the case, it would present no difference in its arm-formula, nor any marked difference in the details of its structure, excepting in the proportional sizes of certain plates. This latter character, however, imparts a material difference to the whole form of the body—a difference, indeed, that is so striking as to be apparent at a glance. For instance, in *B. longirostris* the first and second primary radials and first anal, as well as the first interradial pieces, are all proportionally so much larger (particularly longer) as to make the body below the arms always distinctly longer and proportionally narrower. Another marked difference consists in the convexity of the body plates: those of *longirostris* being only slightly and evenly convex, while in the form under consideration they are decidedly tumid, and sometimes even angular. The arm-bases of the *longirostris* are also more distinctly separated by sinuses, and less robust. In short, the characters mentioned in the species *longirostris* impart to it a peculiar and very characteristic neatness and symmetry of appearance not seen in the form here described.

In form and general appearance our species resembles specimens sometimes supposed to be a broader and more robust variety of *B. subæqualis*, McChesney (sp.), but in that there are four arms to each ray, and the brachial pieces are in close contact all around, while its body plates are not merely tumid, but decidedly tuberculiform and projecting.

Locality and position—Lower Burlington beds of the Lower Carboniferous, at Burlington, Iowa. No. 13 of Mr. WACHSMUTH'S collection.

BATOCRINUS TROCHISCUS, M. and W.

Pl. 5, fig. 6

Batocrinus trochiscus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1868, p. 354.

BODY broad, discoidal or wheel-shaped, being very narrow at the base, and widening gradually to the top of the first radials, thence spreading very rapidly to the brachial pieces, which are large and nearly in contact all around, or but slightly separated by small sinuses over the anal, interradial and axillary spaces. Vault flat, or a little concave from the periphery about half-way in toward the middle, thence rising moderately to the subcentral proboscis; composed of unequal pieces, the larger of which are rather tumid, and arranged in radiating rows coincident with the rays and their division below, while the smaller pieces between are depressed so as to form concavities between the larger.

Base narrow, truncated, but not spreading or provided with a distinct rim below, wider than high, and widening very gradually upward. First radial pieces about of the size of the basal, but proportionally longer, though they are generally wider than long, two of them heptagonal and three hexagonal. Second radial pieces comparatively very small, and all wider than long, or transversely oblong, being, as usual in this group, regularly quadrangular. Third radial pieces about twice as large as the second, wider than long, and all pentagonal, excepting those of the two posterior rays, one of which is hexagonal and one heptagonal, in the specimen from which the description is drawn up; each supporting on each of its superior sloping sides, in direct succession, two secondary radials nearly or quite as large as the third primary radials themselves, while each of the upper of these secondary radials is an axillary piece, supporting on each of its sloping sides, in direct succession, two large brachial pieces, thus making four arm-openings to each ray all around, or twenty in the entire series. First anal piece about of the size of the smaller first radials, longer than wide, and heptagonal in form; above this there are in the second range three smaller hexagonal pieces, and, arching over the latter, four in the fourth range, with a small wedge-formed piece succeeding the latter above, though it is scarcely large enough to separate the brachial pieces over the anal area. First interradial pieces nearly as large as the first radials, and all irregularly nine-sided; above this there are two smaller pieces in the second range, two, or sometimes only one, in the third, and above this one or two succeeding each other in a direct line, the last one being usually narrow, and partly or entirely wedged in between the brachial pieces so as, in some cases, to separate them a little. Between the first divisions of each ray on the third radials there are usually one or two interaxillary pieces, the first resting upon two short sloping upper sides of the first secondary radials, and supporting the second, which sometimes separates the brachial pieces a little, while in other instances it is so narrow and short as to allow them to come in contact over it. (Arms and column unknown.)

The surface seems to be nearly smooth, or finely granular, and the body plates are nearly even, excepting the secondary radials, which, with the brachial pieces, are sometimes a little tumid, so as to project slightly beyond the plane of the interradial and interaxillary areas, which consequently have a somewhat sunken appearance.

Hight of body to arm-openings, 1 inch; breadth, 2.10 inches.

This fine species seems to be most nearly related to *B. planodiscus*, Hall (sp.), from the Keokuk beds, with which it agrees nearly in form and general appearance. It differs very materially in structure, however, since the rays in that species bifurcate so as to make eight arm-openings to each ray, or forty to the whole series, being just double the number seen in our species. The *planodiscus* also appears to have the arm-openings directed outward, while the species under consideration belongs apparently to the section of this genus with these openings directed upward.

It is an interesting fact, to which our attention has been called by Mr. WACHSMUTH, that not only this species, but several others only found in the very highest part of the Upper Burlington formation, are more nearly allied to species found in the Keokuk beds than to any forms in the Lower Burlington beds.

Locality and position.—Upper bed Burlington division of the Lower Carboniferous at Burlington, Iowa. No. 27 of Mr. WACHSMUTH'S collection.

BATOCRINUS PYRIFORMIS, Shumard (sp).

Pl. 5, Fig. 5.

Actinocrinus pyriformis, SHUMARD. Missouri Geol. Report, part ii, p. 192, 1855.
Batocrinus pyriformis, MEEK and WORTHEN. Illinois Geol. Report, Vol. II, p. 150, 1866.

BODY more or less pyriform, being narrow and produced below the second radials, and expanding upward to the arm-bases. Base about twice as wide as high, truncated, and more or less prominent or sub-angular around the lower edge; facet for the attachment of the column, round, rather deeply impressed, and about half as wide as the truncated lower surface of the base; outer surfaces of the basal pieces rising nearly vertically, or contracting a little upward. First radial pieces comparatively large, generally longer than wide, often distinctly so; hexagonal and heptagonal in form, the lateral edges being longer than any of the others; all rising vertically from the basal pieces, so as to form with the latter a short cylindrical extension of the body. Second radial pieces much smaller than the first, wider than long, and presenting the usual quadrangular form. Third radials about as high as the second, but somewhat wider, being always wider than long, and generally heptagonal in form; each supporting on each of its superior sloping sides, in direct succession, two rather large secondary radials, the upper of which are axillary pieces, and bear on their superior sloping sides, large brachial pieces connecting with each other all around, and bearing the free arms.

Anal pieces seven or eight, the first one being similar in form to the first radials, and surmounted by two or three smaller in the second range, over which are two or three in the third range, and above the latter one or two others are seen. Interradial pieces five or six to each space, the largest one supporting two smaller in the second and third ranges, while the others are more or less irregularly arranged above. A small interaxillary piece is also intercalated between the secondary radials of each ray.

Vault prominent, and usually sloping up to the base of the ventral tube; composed of moderate sized convex or tumid pieces; ventral tube or proboscis very long, and gradually tapering to the smaller extremity, where the round opening is seen to be not more than 0.05 of an inch in diameter.

Arms twenty, short, or less than half as long as the ventral tube, rounded on the dorsal side, and rather rapidly tapering, Pinnulæ slender, closely crowded, and composed of joints two to three times as long as wide.

Surface of body plates nearly even, or sometimes a little convex, and nearly smooth; sutures not impressed. Column stout, long, round and scarcely tapering; composed near the body of rather thick joints with rounded edges, alternating with thin discs, which do not always show at the surface, being as it were, impressed into the upper and lower surfaces of the thickest pieces; farther down the pieces are all thick, and of uniform size, being scarcely twice as wide as thick; internal cavity small, and nearly round, or obscurely pentagonal.

Length of body, 1.65 inches; breadth of do., at the arm-bases, 1.25 inches; length of proboscis, 3 inches; thickness of same at smaller end, 0.10 inch; length of arms about 2 inches.

Some varieties of this species, and *B. Christyi*, Shumard (sp.), resemble each other closely, but the body of the latter species is nearly always more depressed and broader, so as sometimes to approach a wheel-shape. A more important difference, however, is to be observed in the number of arms, which in the *Christyi* is forty instead of twenty, there being always two arms springing directly from each arm opening, in that species. The arms of *B. Christyi* are also more slender. Our *B. pistillus*, and *B. pistilliformis*, are also allied to the form under consideration, but differ in various details.

Dr. SHUMARD gave good figures and an accurate description of the body of this species, in the Missouri report; but we have refigured and described it, because we have at hand one of Mr. WACHSMUTH'S specimens showing the arms and ventral tube, all complete. Indeed it is the only specimen of a Crinoid, of the family *Actinocrinidæ*, we have ever seen, with the extreme end of this tube unbroken. It is also interesting, as it shows how impossible it would have been for the animal to have conveyed food to the small opening in the end of this tube, by the direct agency of the arms, as some have supposed, since its arms are scarcely half as long as this tube.

Locality and position—Upper Burlington beds of the Lower Carboniferous series. The beautiful specimen we have figured, belongs to Mr. CHARLES WACHSMUTH, of Burlington, Iowa, who found it at that place, where the species is not uncommon. It also occurs at several localities in Illinois; and Dr. SHUMARD'S typical specimens were found in Marion county, Missouri, at the same horizon as the Upper beds at Burlington.

BATOCRINUS (ERETMOCRINUS?) NEGLECTUS, M. and W.

Pl. 5, Fig. 3.

Batocrinus (Eretmocrinus) neglectus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1868, p. 355.

BODY small, inversely campanulate below the arms, and rather ventricose above; the sides expanding gradually from the base to the third radials, and thence curving out rapidly to the outer edges of the brachial pieces, which are slightly grouped, but nearly or quite in contact all around. Base about three times as wide as high, truncated and concave below, but not thickened or expanded. First radials comparatively large, generally wider than long, and, as usual, two heptagonal and three hexagonal; all like the other body plates, convex, but not properly tumid. Second radials much smaller than the first, quadrangular and nearly twice as wide as long. Third radials as large as the second, or slightly larger, wider than long, and all normally pentagonal; each supporting on each of its superior sloping sides a secondary radial, which in its turn bears on each side above two brachial pieces in direct succession, thus making four arm openings to each ray, or twenty to the entire series.

In one specimen, however, agreeing exactly in other respects, the third radials in the anterior and one in the posterior rays is immediately succeeded by brachial pieces without any further bifurcations, so as to give origin to only two arms to each of these rays; but this is almost certainly an individual abnormal development.

First anal plate a little longer, but not otherwise differing from the first radials; above this there are three smaller pieces in the next range, and sometimes one or two still smaller ones in the third range. Interradial pieces one to three in each space, the first being one-third to one-half as large as the first radials, seven to nine sided, and usually supporting one or two smaller pieces in the second range above.

Vault convex, and composed of very unequal, irregular, moderately convex plates, provided with a tube or proboscis of moderate thickness, and placed generally about half way between the middle and the anal side. (Column and arms unknown.)

Hight to base of proboscis, about 0.58 inch; do. to arm openings, 0.33 inch; breadth, 0.55 inch. The specimen presenting the irregularity mentioned in the arrangement of the arms, is proportionally wider than that from which the above measurements were taken.

This little species is apparently nearer *B. clio*, Hall, (sp.), than to any other yet described. Its base, however, is much less thickened and expanded than in that species, and its body-plates more even and smoother; while its brachial pieces are less prominent, so as to give its body a less spreading appearance. Judging from the description, the *B. laura*, Hall, (sp.), would seem to be somewhat like our species, but that form must be more depressed and proportionally wider, and is also said to have the arm openings directed upward, which would even place it in a different section of the genus.

We place this species provisionally in the *Eretmocrinus* group, from its general appearance, as we have not seen any specimens showing the arms.

Locality and position—Lower division Burlington group of Lower

Carboniferous, at Burlington, Iowa. No. 14 of Mr. WACHSMUTH'S collection.

BATOCRINUS CHRISTYI, Shumard's sp.

Pl. 5, Fig. 4.

Actinocrinus Christyi, SHUMARD. Geol. Survey of Mo., Part 2, p. 191; Pl. *a*, Fig. 3.

BATOCRINUS VERNEUILIANUS, Shum. sp.

Pl. 4, Figs. 3 and 4.

Actinocrinites verneuilianus, SHUMARD, 1855. Geol. Survey of Mo., Part 2, p. 193; Pl. *a*, Fig. 1.

(Specimens of this species, showing stem, proboscis and arms: Burlington limestone, Sagetown, Illinois, and Burlington, Iowa.)

GENUS DORYCRINUS, Rœmer.

In the second volume of the Reports of the Geological Survey of Illinois we distinctly recognized the *Dorycrinus* group as forming a well defined genus, clearly separated from *Actinocrinus* (as properly restricted), to which genus they have generally been referred; but owing to the fact that at that time we had never seen either a speciman or a figure of an *Amphoracrinus* showing the arms, body and parts connected with the opening of the vault, all preserved together, we were under a misapprehension in regard to the true characters of that group, and consequently placed *Dorycrinus* as a synonym under it. Recently, however, we have been so fortunate as to see in Mr. WACHSMUTH'S extensive collection beautiful specimens of both types, in a remarkably fine state of preservation, and from these we are satisfied that a systematic classification of the *Crinoidea* requires these two groups to be separated as distinct genera.

In the first place, it may be proper to remark that in both of these groups the structure of the body, so far as regards the number and arrangement of the pieces below the arm-bases, is almost exactly the same as in *Actinocrinus*.* The structure of the parts above, however, is very different. For instance, in *Dorycrinus* the opening of the vault is never at the end of a more or less prolonged tube, or so-called proboscis, nor even in the slightest degree proboscidiform, but is merely a simple aperture penetrating a somewhat thickened protuberance, and nearly always situated and opening laterally. The vault in this group is generally provided with a more or less prominent spine over each ray and a sixth one in the middle. Sometimes these are all, or in part, merely represented by nodes, or even in some instances nearly obsolete, while in others they are extravagantly developed. Again, *Dorycrinus* differs from both *Actinocrinus* and *Amphoracrinus*, in having, so far as yet known, always *two arms springing directly from each arm opening, and these arms always simple.* Our attention was first called to this by Mr. WACHSMUTH, who is a very careful and accurate observer, and we found it to be so in all the specimens in his collection, while he assures us that this is the case in all the specimens found by the various collectors at Burlington, as well as all of those he has yet seen from other localities, with the arms attached. Hence in all of the species of this group described by Prof. HALL and others, where the number of arms has been given merely from counting the arm openings—and specimens of these have since been observed with the arms attached—their number is found to be *just double that stated in the descriptions.* It is also worthy of note that in this group the body plates are either plane, more or less tumid, or tuberculiform, and never marked with proper radiating costæ, as we often see in *Actinocrinus*.

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* *Dorycrinus*, however, differs from *Actinocrinus*, in having the second radial pieces nearly always short and quadrangular, instead of hexagonal.

The following is a list of the described species belonging to this group, all of which are, so far as known, exclusively American types, and confined to the Lower Carboniferous, viz: *Dorycrinus Mississippiensis*, Rœmer, and *D. Gouldi*,[†] *D. cornigerus*,* *D. divaricatus*,* *D. trinodus*, *D. quinquelobus*,* *D. symmetricus*,* *D. desideratus*, *D. unispinus*,* and *D. subaculeatus*, Hall (sp.), all of which were described by Prof. HALL under the name *Actinocrinus*. It likewise includes *D. Missouriensis** (=*Act. Missouriensis*, Shumard,) and *D. unicornis** (=*Act. unicornis*,[‡] Owen and Shumard,) as well as our *D. subturbinatus*,* originally described as an *Actinocrinus*.

It might at a first glance be supposed also to include *Actinocrinus corniculus* and *A. brevis* of Hall, but these forms (which Mr. WACHSMUTH'S collections clearly show to be only varieties of one species) have but a *single* arm from each arm opening (two to each ray), and these arms, with the proportional stoutness, general structure, and broad pieces at their bases, of *Agaricocrinus*. Hence this species can only be regarded as a somewhat aberrant form of the latter genus.

[†] Specimens of all the species marked with an asterisk have been found with the arms attached, and presenting the characters mentioned above. The arms of the others remain unknown.

[‡] The proposed species *A. tricornis* and *A. pendens*, Hall. are believed to be only varieties of *unicornis* of O. and S.

DORYCRINUS CANALICULATUS, M. and W.

Pl. 6, Fig. 4.

Dorycrinus canaliculatus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 166.

BODY under medium size, cup-shaped below the arms, rather rapidly expanding from the lower margins of the first radials to the arm bases. Base extremely short, its entire hight merely consisting of the thickness of the plates, subhexagonal in outline, with small lateral notches at the sutures, scarcely projecting below the first radial and first anal piece; facet for the attachment of the column occupying about half the breadth of the base, round and rather deeply impressed. First radial plates about once and a half as wide as high, all very nearly hexagonal, there being scarcely any perceptible angle at the middle of those over the sutures of the base. Second radials scarcely half as large as the first, about once and a half as wide as long, and presenting the usual quadrangular outline. Third radials a little wider and shorter than the second, pentagonal in form, and bearing on their upper sloping sides, in the posterior rays, two slightly smaller secondary radials, each of which supports two brachial pieces, thus giving origin to four arm openings to each of these two rays; while in the anterior ray one side of the third radial merely bears a series of brachial pieces leading to an arm, and its other side a tertiary radial, supporting two brachial pieces, thus making three arms to this ray. In both anterior lateral rays each third radial bears on each side two brachial pieces in direct succession, making only two arm openings to each of these rays, or fifteen to the entire series.*

Anal pieces about eight, below the horizon of the arm openings; first one as wide as the first radials, and a little longer, heptagonal in form, and bearing three smaller pieces in the second range, above which there are five smaller

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*Sixteen is probably the *normal* number.

pieces in the third range, connecting with others extending up to the opening of the vault. First interradials nearly half as large as the first radials, heptagonal in form, and bearing two smaller pieces in the second range, above which one or two small pieces intervene to separate the brachial pieces, and connect with the vault.

Vault about two-thirds as high above the arm openings as the hight of the body below, provided with a single, rather pointed and prominent central node, that may be in some instances developed into a short spine. Opening with margins a little projecting and situated in a slightly impressed area above the horizon of the arm openings.

Body plates convex, separated by deeply canaliculated sutures, and roughened by a peculiar shallow pitting over the entire surface, but which is larger and deeper at the edges of the larger plates, to which it imparts a slightly crenate appearance. The plates of the vault are also defined by the same deeply canaliculate sutures, and roughened by similar pitting to that on the body plates, though they are not convex like the latter.

As we have not seen the arms of this species it is barely possible that it may be more properly an aberrant *Agaricocrinus* than a true *Dorycrinus*. Its arm bases, however, or rather the brachial pieces, have not the breadth and stoutness seen even in the most aberrant species of the former group, such as *Agar. corniculus* (= *Act. corniculus*, Hall), and from their appearance there is little room for doubting that it had two slender arms from each arm opening, instead of a single stout one as in *Agaricocrinus*, which, so far as we are aware, never has more than three arm openings to each posterior ray, and two or three to each of the others. It is the only species we have ever seen of the *Dorycrinus* group with the peculiar sculpturing of its body plates already mentioned. This sculpturing, however, is very different from that seen on *Agaricocrinus corniculus*, which the species most nearly resembles in several respects, being a peculiar pitting of the whole surface of each individual plate, with a few larger marginal indentations. Its greater number of arm openings (four to each posterior ray, and three to the anterior one, instead of two to each all around), would alone at once distinguish it from that species, even in specimens without the arms.

Locality and position—Lower bed of Burlington Limestone, Burlington, Iowa. Lower Carboniferous. No. 150 of Mr. WACHSMUTH'S collection.

DORYCRINUS UNICORNIS, O. and S., sp.

Pl. 6, Fig. 2.

Actinocrinus unicornis, OWEN and SHUMARD, 1850. Jour. Acad. Nat. Sci., Phila., Vol. 2, new series, p. 67. Geol, Rep. Iowa, Wis. and Minn., p. 593. Pl. 5 A, fig. 12.

(Burlington Limestone, Burlington, Iowa. Mr. WACHSMUTH'S collection.)

DORYCRINUS RŒMERI, M. and W.

Pl. 10, Fig. 3.

Dorycrinus Rœmeri, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1868, p. 346.

BODY somewhat urn-shaped, being obconical below the arms to the truncated base, and moderately prominent above, the vault forming rather more than one-third of the entire hight; greatest breadth at the arm-bases. Base truncated and somewhat concave below, about twice as wide as high, slightly expanded and a little angular below, with broad, rather shallow notches at the sutures. First radial pieces about twice and a half as wide as high, two heptagonal and three hexagonal, each one swelling out so as to form a moderately prominent, rather obtuse, transversely elongated node. Second radials one-third to nearly one-half as long as the first, quadrangular, a little wider than long, and more or less tumid. Third radials rather larger than the second, wider than long, pentagonal, hexagonal and heptagonal; each one supporting on each of its superior sloping sides a pentagonal secondary radial, of rather smaller size, each of which in the posterior rays supports in its turn, on each side above, one, or sometimes two brachial pieces, making four arm openings to each of these rays. This seems to be the case also in the right lateral ray, while one of the secondary radials, in the specimen studied, appears to be merely truncated, so as to support (perhaps abnormally) only one brachial piece, thus making only three arm openings to this ray. The brachial and secondary radial pieces of the anterior ray are broken away in the specimen, but it is probable there were four arm openings in this ray. If so there would be nineteen arm openings (probably normally twenty) in the entire series, and thirty-eight to forty arms, counting two to each opening.

First anal piece of the same size and form as the first radials, and, like them, swelling out into a transversely elongated node. Above this there are two heptagonal and one apparently hexagonal rather tumid pieces in the second range, and above the latter several other pieces extending up between the arm-bases, so as to connect with a series of pieces forming a thickened protuberance rising even slightly higher than the summit of the vault, and pierced by the anal opening, which is situated considerably above the horizon of the arm-bases, but still directed laterally. Interradial pieces, three to each area, the first being about half as large as the subradials, heptagonal or octagonal, and supporting two somewhat elongated, irregularly formed pieces, that are scarcely convex, and connect by their narrow upper ends with vault pieces above. Vault somewhat rounded, with lateral spines very short, or merely having the form of rather prominent conical nodes; central piece somewhat tumid, but not even conical. Arms and column unknown.

Named in honor of Dr. F. ROEMER, the founder of the genus *Dorycrinus*.

Hight of body to top of vault, 1.40 inches; do. to top of anal protuberance, 1.45 inch; breadth at arm-bases, 1.30 inch; breadth of base, 0.55 inch.

This species is perhaps more nearly allied to *D. Missouriensis*, Shumard (sp.), than to any other yet known. It will be readily distinguished, however, by several well marked characters. In the first place, its base is not thickened and expanded as in that species. Again, its vault is not so flattened on top, nor the spines, or tumid pieces over the rays, near so large. In the *Missouriensis* the latter character is so strongly marked as to place the widest part of the body above the arm-bases, which consequently have the appearance of being attached half way down the sides of the body, while in the species under consideration the body is distinctly wider at the arm-base than above. Our species has also seven or eight arms more than Dr. SHUMARD'S.

Those who prefer to view the *Dorycrinus* group as only a section of *Actinocrinus* will, we hope, at least write the name of this species *Actinocrinus (Dorycrinus) Rœmeri.*

Locality and position—Upper part of the Burlington beds of the Lower Carboniferous series, at Burlington, Iowa. No. 127 of Mr. WACHSMUTH'S collection.

DORYCRINUS QUINQUELOBUS, var. INTERMEDIUS.

Pl. 10, Fig. 4.

Dorycrinus quinquelobus, var. intermedius, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1868, p. 346.

On comparing this form with the typical specimen of *D. quinquelobus (=Actinocrinus quinquelobus,* Hall, Supp. Iowa Geol. Report, Vol. I, p. 15,) we find that it agrees very closely in the structure of its body, as well as in the number of arm openings in each ray (that is, four to the anterior and each posterior ray and two in each of the lateral rays), but at the same time it presents some other differences, that we suspect may be even of specific importance. In the first place it is larger and more robust, and has a proportionally smaller base, and rather distinctly tumid, instead of even body plates, while its interradial and anal spaces are not near so deeply excavated between the arm-bases as in the type of *quinquelobus*. Its third radial pieces also differ in form, being so narrow in all the rays as to let the secondary radials come in contact with the first interradial and the second range of anal pieces, instead of extending around so far laterally as to separate these pieces. Its vault is likewise more flattened on top.

In the typical specimen of *D. quinquelobus* the spines of the vault have all been accidentally removed, but in the form under consideration they seem to have been short and stout, though their entire length is not known, as they were apparently broken off during the life of the animal, since they each have the broken end somewhat rounded and indented in the middle. In size and general appearance it is more like *D. Mississippiensis* of Rœmer, butit differs in having rather more tumid body plates, as well as in the number of the arm openings, that species having four of these openings to each ray all around. It also has a more protuberant anal opening, and probably had much shorter vault spines. It therefore seems to be somewhat intermediate between the *D. Mississippiensis* and *D. quinquelobus*, but is probably distinct specifically from them both. As we have but a single specimen, however, of it, and the typical specimen of *D. quinquelobus* for comparison, we prefer to place it for the present as a variety of that species, under the name *intermedius*, and if it should hereafter be found that the differences we have pointed out are constant, it can take the name by which we have proposed to distinguish it as a variety, as a specific name.

Locality and position—Upper part of the Burlington division of the Lower Carboniferous series, at Burlington, Iowa. No. 164 of Mr. WACHSMUTH'S collection.

GENUS AMPHORACRINUS, Austin.

As already stated, this group agrees with *Actinocrinus* in the number and arrangement of the pieces composing the under side of the body, as well as in having the parts adjacent to the arm bases forming five projecting lobes, distinctly separated from each other by the anal and interradial sinuses. It differs from them both, however, in the structure of the parts above, as well as in having the body generally more depressed or even flat below, and the vault proportionally more ventricose, while its second radial pieces are more generally hexagonal than in *Dorycrinus*. From the latter it also differs in having the opening of the vault more or less probosciditorm,* and placed nearly half way between the middle and the anal side, instead of being a simple generally lateral aperture, penetrating laterally a merely thickened protuberance. The probosciditorm extension of its vault, however, is never so long and slender as we usually see in *Actinocrinus*, and also often differs in being crowned with small spines surrounding the very small terminal aperture, which seems always to open *upward*. As in *Dorycrinus*, the vault is generally more or less spiniferous, though the spines are differently arranged, and, as far as yet known, never so extravagantly developed as we sometimes see them in that group. Some of the species are known to have one of the vault pieces over each ray more or less protuberant, and it may be the case that species existed in which those were developed into spines, somewhat as in *Dorycrinus*, though we are not aware that any such have yet been found. Near the middle of the vault there is also a large tumid piece, sometimes developed into a short spine, while around the anterior side of this four or five similar pieces are semi-circularly arranged, which also often become well developed spines.

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* In all the foreign specimens of the typical species of *Amphoracrinus* that we have seen, only the broken base of this short proboscis remains; and this also seems to have been the case with nearly all those from which the published figures, which we have had an opportunity to examine, were drawn. CUMBERLAND, however, has given a figure in his Reliquæ Conservatæ (Pl. C), apparently of the typical species *amphora*, with the short, oblique proboscis well preserved. This will be seen to differ materially from the merely slightly protuberant thickening in which the opening in *Dorycrinus* is situated.

We have never seen any figures or specimens of the European typical species of *Amphoracrinus* showing the arms, but there are in Mr. WACHSMUTH'S collection several beautiful specimens, found at Burlington, agreeing exactly in all other characters (not merely specific) with the types of the genus, in which the arms are perfectly preserved. In these we observe marked differences, both from *Dorycrinus* and *Actinocrinus.* For instance, in *Amphoracrinus divergens* (=*Actinocrinus divergens*, Hall), the arms, although *bifurcating so often as to form altogether about fifty-three or more divisions*, are each, as well as each of these divisions, composed of a double series of very short alternating pieces *all the way down, even below all the bifurcations to their very bases*, with the exception of one to two or three simple brachial pieces, at the origin of each main arm on the last primary or secondary radials.

The structure of the arms, it will be seen, is the same as in *Saccocrinus* (an otherwise different type), but widely different from what we see in *Actinocrinus*, in which the arms are always composed of a *single series* of pieces *below* such bifurcations as take place. It is also even more decidedly different from that of *Dorycrinus*, in which the arms not only never bifurcate in any of the species in which they are known, but are also arranged so that two of them spring directly from each arm opening without imparting to the brachial piece on which they rest the usual form of an axillary piece.

In one species, however, (*Actinocrinus spinobrachiatus*, Hall), having apparently all the other characters of *Amphoracrinus*, the arms do not bifurcate after their origin on the axillary secondary radial pieces. It seems, therefore, probable that there are some species of this group with simple arms, and others that have them more or less frequently bifurcating. The probability is, however, that in *all* cases when they *do* bifurcate, that they are equally composed of a double series of small alternating pieces *below* the bifurcations as well as above, the same as in the species *divergens.* Whether we include such species as the *spinobrachiatus*, however, with merely *simple arms*, composed like the others, of a double series of alternating pieces throughout their entire length, as a separate section of *Amphoracrinus*, or view them as forming a distinct group, they need not for a moment be confounded with *Dorycrinus*, from which they not only differ in form, surface markings, opening of the vault, etc., but also in never having two arms springing directly from each arm opening.

In all the species of *Amphoracrinus* known to us, either foreign or

American, it is also worthy of note that the surface of the body plates is never ornamented with proper radiating costæ, such as we often see in *Actinocrinus* and other allied types, nor yet smooth, or properly tuberculiform, as in *Dorycrinus*, but always presents a peculiar vermicular style of sculpturing or corrugation difficult to describe, but very characteristic and easily recognized again after being once observed.

To this group Mr. WACHSMUTH has in MS. correctly referred the following American species, viz: *Amphoracrinus divergens*, *A. planobasalis*, *A. spinobrachiatus?* and *A. inflatus*, described by Prof. HALL under *Actinocrinus;* also *Actinocrinus quadrispinus*, White; all from the lower division of the Burlington beds.

AMPHORACRINUS DIVERGENS, Hall (sp.)

Pl. 6, Fig. 6.

(Proceed. Acad. Nat. Sci., Phila., 1868, p. 348.)

Actinocrinus divergens, Hall. Supp. Iowa Report, p. 36, 1860.

This species was apparently described by Prof. HALL from imperfect specimens, showing only a few of the lower bifurcations of the arms, since he thought it probably had only twenty-two arms, while perfect specimens in Mr. WACHSMUTH'S collection show that they continued bifurcating farther up, so as to make the whole number about fifty-three or more, as already stated in another place.

Amongst Mr. WACHSMUTH'S specimens there is one (No. 136) with arms, body, vault and proboscis all in a remarkably fine state of preservation, which appears to agree very closely with the *A. divergens* in most of its characters, and yet differs in several respects. It has very nearly the same number of ultimate divisions in the entire series of arms, though there are differences in the details of their mode of divisions, so that the number of arms in any one of the rays is different from what we see in the corresponding ray of *A. divergens*. In each of its posterior rays there are, as near as can be made out, thirteen to fifteen arms; in one of the lateral rays and the anterior one, each eight, and the other lateral one eleven or twelve. Its ventral tube (proboscis) is rather stout, about one inch in length, and crowned by some six or seven small unequal spines, subspirally arranged. At the anterior side of the base of the proboscis, and nearly at the center of the vault, there is a large tumid piece, and on each side of this a spine about three-fourths of an inch in length, directed obliquely outward, upward and forward, and in front of these two other prominent or subspiniform pieces. In the typical *A. divergens*, these two anterior lateral larger spines each *bifurcate*, while in the specimen under consideration they are *simple*. The usual vermicular markings of the body plates in the specimen are well defined, and on the upper anal and vault pieces, as well as on those composing the proboscis, and even on the spines, the whole surface of which is occupied by rather coarse granules. As in the other species of this group, the arms of which are known, they extend at their bases, first horizontally outward, or even a little downward, and then curve upward.

It is probable that this specimen, with simple instead of bifurcating vault spines, and somewhat differently divided arms, may be specifically distinct from the *A. divergens*. If so, we would propose to call it *Amphoracrinus multiramosus*.

AMPHORACRINUS ? SPINOBRACHIATUS, Hall (sp).

Pl. 6, Fig. 5.

Actinocrinus spinobrachiatus, Hall, 1860. Supp. Geol. of Iowa, p. 6.

(Burlington Limestone, Burlington, Iowa. Mr. WACHSMUTH's collection.)

GENUS GILBERTSOCRINUS, Phillips.

SUBGENUS GONIASTEROIDOCRINUS, Lyon & Casseday, 1859.

Syn. *Trematocrinus*, Hall, 1860.

GONIASTEROIDOCRINUS TENUIRADIATUS, M. and W.

Pl. 11, Fig. 1.

Goniasteroidocrinus tenuiradiatus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 75.

THE only specimen of this species we have seen is too much crushed to admit of a detailed description of the structure of its body. It evidently attained a medium size, however, and has unusually long, slender, pseudobrachial appendages, or false arms; while its subradial pieces are produced into short, pointed spines. Its false arms are each composed, near the body, of a double series of alternating semi-elliptic pieces, which are joined together by their straight sides, and each pierced by a small central canal. At a distance of about three or four pairs of these pieces from the body, each series of pieces diverges from the other at an angle of about fifty degrees, thus forming two very long, slender, rounded, gradually tapering branches, composed each of a single series of round pieces, generally less than twice as wide as long, with a small central canal. These pieces have their articulating surfaces radiately striated, and could not be in any way distinguished from the joints of the *column* of many crinoids, if found detached.

From Prof. HALL'S species *typus** (which also belongs to the section of the genus with the pseudo-brachial appendages composed, near the body, of a double alternating series of pieces, and bifurcating farther out into two rounded branches, composed each of a single range of pieces pierced by a small central canal), the species under consideration will be readily distinguished by its much longer and more slender pseudo-brachial appendages, which have their pieces merely rounded and finely granular, instead of being each provided with a row of small tubercles around the middle. From *G. tuberculosus*, Hall, (sp.), which, if correctly identified among the specimens before us, has its pseudo-brachial appendages constructed, at the base at least, in the same way, it will be distinguished by having its subradial pieces produced into short pointed spines, instead of being merely tuberculiform. The same character, as well as its larger size, and more robust appearance, will also distinguish it from our *G. fiscellus* and *G. reticulatus*, Hall, (sp.)

The specimen is too much crushed to afford measurements of the body; but the false arms measure 0.60 inch from the body out to the point of bifurcation, and 0.35 inch in breadth. Each of the branches near the point of bifurcation measures only 0.18 inch in thickness, while one of them can be traced to a length of 2 inches, where it is broken off, and measures 0.13 inches in thickness, the whole length of each branch being probably not less than three inches.

Locality and position—Lower division of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 308 of Mr. WACHSMUTH'S collection.

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* As this species is neither the type of the genus *Gilbertsocrinus* nor of the sub-genus *Goniasteroidocrinus*, the name *typus* can only serve to confuse and mislead the student in regard to the history and synonymy of the genus, and hence ought to be changed.

GONIASTEROIDOCRINUS OBOVATUS, M. and W.

Pl. 1, Fig. 6.

Goniasteroidocrinus obovatus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 76.

BODY rather large, truncato-obovate, being narrow below, with convex sides, and truncated above; hight a little greater than the breadth. Base small, and very deeply concave; basal pieces entirely within the concavity of the under sides, and hidden by the column, when it is attached; apparently completely inverted by the pushing in, as it were, of the column, around which they are folded down with their outer sides inward, while their edges that join to the subradials are turned downward. Subradials of moderate size, very tumid or tuberculiform, but not pointed; curving into the concavity below, and upward at the outer ends, while their tumid central part forms the base upon which the body stands when placed upon a plane surface; all heptagonal in form, if we count an obtuse angle at the middle of the base of each. First radial pieces about as large as the subradials, tumid, and of nearly equal length and breadth; all heptagonal in outline. Second radial pieces generally smaller than the first, and proportionally a little narrower, rather tumid, and all hexagonal in form. Third radial pieces of about the same size as the second, or sometimes slightly larger, equally convex, pentagonal or hexagonal in outline, and each supporting on their superior sloping sides, convex secondary radials, the second of which is sinuous above, so as to form the under side of the openings to which the pendant true arms connect, while on their outer sloping sides they connect with a series of small pieces, which unite with others coming in the same way from the adjacent ray, so as to form the under side of the base of the false arms over each interradial and anal space.

Anal and interradial areas of an oval outline, and scarcely distinguishable from each other, each occupied by twelve to fourteen more or less convex, or tumid pieces, the first of which is hexagonal, about as large as the second radials, and rests as usual on the upper truncated side of a subradial; above these there are usually three arching ranges of three each, and three or four other pieces still farther up, more or less irregularly arranged.

Vault flat, not quite equaling the greater breadth of the body below, and composed of irregular tumid pieces, generally of rather small but unequal sizes, with a more or less marked depression opposite each false arm; opening, apparently nearly central. False arms composed at their bases of four rows of small pieces above, and two below, arranged so as to enclose two distinct canals which do not pierce any of the pieces themselves.

Surface very finely granular. Impressions at the corners of the plates also sometimes cause the appearance of a tendency to form a short obtuse radiating rib at each side of some of the plates, but this character is too faintly marked to attract attention.

Hight of body, about 1.70 inch; breadth, 1.60 inch.

The most marked feature of this species is its rather obovate form, produced by the narrowness of its lower part and its convex sides, and slight contraction near the top. The narrowness of its lower part results from the small size of its basal, subradial, and first radial pieces. The deeply sunken character of its base also contributes to the same result, as it is not near so wide as it would be if its pieces extended out horizontally from the column, instead of being folded down with their backs against it. It seems to resemble *G. tuberculosus*, Hall (sp.), more nearly in general appearance than any other species known to us, but will be readily distinguished, not only by its different form, but by the proportionally smaller size of its basal, subradial, and first radial pieces, but more particularly by the structure of its false arms, which are each composed at the base of six ranges of pieces, instead of only two.

Locality and position—Upper division, Burlington group, Burlington, Iowa. Lower Carboniferous. No. 379 of Mr. WACHSMUTH'S collection.

GENUS MEGISTOCRINUS, O. and S., 1850.

Proceed. Acad. Nat Sci., Phila., 1869, p. 163.

THE type upon which this genus was founded (*M. Evansii*, O. and S.*) has a short, broad, cup-shaped body, with a depressed vault, and sides moderately expanded above, and rounded under below to the flat, anchylosed base, which is usually a little impressed, or less prominent than the first radial and first anal pieces, extending horizontally outward all around it so as to form a part of the under side. In some species the base is not properly impressed, though it can rarely be said to project beyond the surrounding next range of pieces. The body plates are moderately thick, and separated by well defined or rather deep sutures, so as to present a more or less convex surface, without sculpturing or radiating costæ, though there are rarely small indentations at the corners of some of the plates.

The nearly or quite flat vault is composed of unequal, irregular, more or less tumid or convex pieces of moderate size, the middle one sometimes rising into a prominent, rather pointed node, that may be in some cases even developed into a short spine. The opening is decidedly lateral, often penetrating the anal side *below* the horizon of the arm-bases; sometimes it is on the same horizon as the arm openings, or rarely slightly above them. It is never situated in a thickened protuberance, however, as in *Dorycrinus* and *Agaricocrinus*, but always shows thin, broken, abruptly projecting edges, as if, when entire, it had been produced into a short, slender tube, or so-called proboscis, projecting out horizontally backward.

In the number and arrangement of the pieces composing the walls of the body up to the third radial pieces, inclusive, this genus presents no essential differences from *Actinocrinus*, with which it also agrees in having the arm-bases more or less grouped, or separated by interradial and anal spaces, and never forming a continuous series all around, as in *Batocrinus*,† nor an expanded disc, as in *Strotocrinus*. It not only differs from *Actinocrinus* proper, however, in general physiognomy and the nature and position of the opening, but particularly in having its arms each composed of a double series of alternating pieces *below all the bifurcations*, as in *Amphoracrinus*, from which, however, it differs widely in other respects. The peculiarity of having the arms each composed of a double series of alternating pieces *below* as well as above the bifurcations, is not only continued down *to* the body, but in some species each division of the rays included as a part of the walls of the body has the same structure nearly one-fourth of the way down the side, to within one or two pieces of the third primary radials.

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* OWEN's Geol. Report, Wisconsin, Iowa and Minnesota, pl. 5 *a*, fig. 3.

† We cannot believe that those remarkable truncated forms, with arm-bases in contact all around, and an erect subcentral proboscis, such as *M. spinosus*, of Lyon (Proceed. Acad. Nat. Sci., Phila., 1861, pl. 4, fig. 7,) really belong to *Megistocrinus*.

The six or seven known true typical species of this genus form so natural a group that they can be readily distinguished at a glance from the allied genera: such as *Amphoracrinus*, *Agaricocrinus*, *Dorycrinus*, *Cælocrinus*, *Strotocrinus*, *etc.* There is, however, at least one, and probably two known Carboniferous species, standing, as it were, between *Megistocrinus* and *Saccocrinus*, and combining the characters of both to such an extent that one of them (*Act.* (*Megist.*) *Whitei*, Hall,) was referred by Prof. HALL to *Megistocrinus* (which he seems to regard as a section or subgenus of *Actinocrinus)*, while the name of the other was written by us *Actinocrinus (Saccocrinus?) amplus*[*] because we were convinced that it is not a *true Actinocrinus*, and believed it related to *Saccocrinus*. From direct comparisons with Prof. HALL'S typical specimens of the species *M. Whitei*, in the Museum of the University of Michigan, Professors WINCHELL and MARCY were also led to refer Silurian species of *Saccocrinus* to *Megistocrinus*.

The Silurian typical forms of *Saccocrinus* have the same arm structure, as well as essentially the same arrangement of body plates, as *Megistocrinus*, but differ in having a much more elongated, narrow body, composed of thin, even plates (without excavated sutures) and a protuberant obconic, instead of a flat or impressed base; also a subcentral opening (or proboscis?) instead of a decidedly lateral proboscidiform opening in the vault; thus presenting a decidedly different general physiognomy from the typical Carboniferous forms of *Megistocrinus*. If we had only the typical forms of these two groups to deal with, there would be no difficulty in separating them. The two species or varieties, *Whitei* and *amplus*, however, are not so easily disposed of, since they have the same thin, smooth plates, without impressed sutures, seen in *Saccocrinus*, and nearly as protuberant a base, while their body is exactly intermediate in form, and their arm structure the same as in both of these groups, with which they also equally agree in the number and arrangement of the body plates. We have never seen a specimen of any of the Silurian species of *Saccocrinus* showing the vault, but all the casts we have examined seem to show that it was nearly flat, and had either a subcentral opening or proboscis, and no traces of a decidedly lateral opening, as in typical forms of *Megistocrinus*. A specimen figured by Dr. ROEMER, in his work on the Silurian fossils of Tennessee, shows the vault to be protuberant in the middle, and provided with an opening there, with some appearance of being surrounded by the remains of the base of a proboscis, though it may possibly be only a simple opening in a prominence. In the Carboniferous species *Whitei*, as already stated, there is a small subcentral opening in the depressed vault, without any traces of a proboscis, and we can now scarcely doubt that this is the case with the *amplus*, and the vault of both these species also differs from that of the typical *Megistocrinus* in being composed of innumerable minute pieces.

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[*] It is possible, as already intimated, that this may not be distinct from Prof. HALL'S species *Whitei*, but as it is larger and more robust, however, and has its body plates more convex, and without the ridge seen extending up the radial series of the species *Whitei*, which also differs in some other details, and came from the upper part of the Burlington beds, and ours from the lower, while scarcely any species of Crinoids are believed to be common to these two horizons, we are not entirely convinced that they are identical. All the specimens of the species or variety *amplus* we have seen are in a more or less crushed condition, which in some instances caused the vault to protrude in such a way as to lead us to believe it provided with a central or subcentral proboscis, especially as several of the specimens clearly show that it certainly has no traces of a lateral opening anywhere near the anal side, as in the typical forms of *Megistocrinus*. Mr. WACHSMUTH informs us, however, that he has recently found a specimen of the species *Whitei* showing that it has a small subcentral simple opening much as in *Strotocrinus*, section *(a)*, and from the close relations of our *amplus* to that species, it is highly probable that it also has a similar opening, without a proboscis.

Although there are a few points in regard to the relations between these groups that we have not yet been able entirely to clear up, we are, from all the facts now known to us, inclined to believe that *Saccocrinus* should be ranged as a subgenus under *Megistocrinus*. At any rate, if the species *Whitei* and *amplus* are to be included under *Megistocrinus* at all, we think they should certainly be at least placed in a separate subgenus from the typical forms; and until these questions can be more definitely settled, from the study of more extensive collections, we prefer to retain for this subgenus the name *Saccocrinus*. With these limits, the genus *Megistocrinus* would include the following American Carboniferous forms:

1. MEGISTOCRINUS, Owen and Shumard, 1850.

Body short, broad, and composed of rather thick convex pieces; base flat, impressed, or scarcely more prominent than the first anal and first radial pieces; vault composed of moderate sized convex pieces; opening decidedly lateral, produced in the form of a small, short proboscis ? and directed posteriorly.

Megistocrinus Evansii, Owen and Shumard, *M. plenus*, *M. crassus*, White; and *M. brevicornis* and *M. superlatus*, described by Prof. HALL under *Actinocrinus*. Also our *M. parvirostris* of this paper. All of which are from the Lower Carboniferous.

? 2. Subgenus SACCOCRINUS, Hall, 1852.

Body usually more elongated, with a protuberant base; body plates thin, even, or not convex; vault composed of small or minute pieces, and provided with a small subcentral simple opening, or possibly sometimes with a proboscis.

Actinocrinus (Megistocrinus) Whitei, Hall, *and Act. (Saccocrinus ?) amplus*, M. and W.

MEGISTOCRINUS PARVIROSTRIS, M. and W.

Pl. 6, Fig 7.

Megistocrinus parvirostris, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 165.

BODY rather small, of the usual short cup shape, about one-fourth wider than high. Base nearly even with the surrounding first radial and first anal pieces. First radials near one-third wider than long. Second radials a little smaller than the first, hexagonal in form. Third radials as wide as the first, but shorter, pentagonal or hexagonal, and each supporting on each superior sloping side two brachial pieces in direct succession, upon the last of which rest two or three series of double alternating pieces before the commencement of the free arms, making two arm openings to each ray, or ten to the entire series. First anal piece wider and a little shorter than the first radials, supporting three smaller pieces in the next range, above which there are four or five in the third, and five in the fourth ranges, which latter connect with numerous very small pieces forming and surrounding the little short proboscidiform opening. First interradials about as large as the second radials, and bearing two smaller pieces in the second range, three in the third, and two or three in the fourth, with a few minute pieces in the latter.

Vault a little convex, composed of moderate sized, convex or tuberculiform pieces, the largest and most prominent of which is in the middle, and the others surrounding it, while a few minute pieces are intercalated between and around the latter, particularly on the anal side. Anal opening in a short, little proboscidiform protuberance, placed entirely below the horizon of the arm bases, and directed a little obliquely downward. Body plates, excepting the small ones, connected with the opening, all rather tumid, and separated by excavated sutures, somewhat indented at the corners of the plates. Arms and column unknown.

Hight of body to top of central node of the vault, 0.80 inch; breadth, 0.96 inch; hight to arm openings, 0.58 inch; do. to anal opening, 0.38 inch.

This species is apparently most nearly allied to *M. brevicornis*, Hall (sp.), but differs in having a greater number of ranges of brachial pieces included as a part of the walls of the body, and these pieces wider and commencing as double series farther down. Its opening is also placed decidedly lower even than the proposed species *Act. minor*, of Hall, being distinctly below the horizon of the lower edge of the arm openings, and nearly half-way down the side, measuring from the highest part of the vault. Its larger vault pieces, excepting the middle ones, are also more prominent and pointed. Its body and vault plates are all much more convex, its arm bases stouter, its vault less depressed, and its opening decidedly lower than in *M. superlatus*, Hall (sp.)

Locality and position—Upper Burlington beds of the Lower Carboniferous, at Burlington, Iowa. No. 161 of Mr. WACHSMUTH'S collection.

MEGISTOCRINUS (SACCOCRINUS) WHITEI, Hall.

Pl. 6, Fig. 1.

Actin. (Megistocrinus) Whitei, HALL, 1861. Jour. Bost. Soc. Nat. Hist., Vol. 7, p. 271.

(Burlington Limestone, Burlington, Iowa. Mr. WACHSMUTH'S collection.)

GENUS AGARICOCRINUS, Troost.

AGARICOCRINUS NODOSUS, M. and W.

Pl. 10, Fig. 7.

Agaricocrinus nodosus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 167.

BODY without the arms, having a truncato-suborbicular general outline, being convex above and broadly truncated below; under side moderately concave out to the second radial pieces inclusive. Base small, impressed deeper than the general concavity of the under side, and entirely hidden by the column. First radial pieces extending out horizontally from the end of the column, and exposing a flat hexagonal surface nearly twice as wide as long. Second radials nearly as large as the first, a little wider than long, and presenting the usual quadrangular form. Third radials tumid, or projecting distinctly beyond the surface of the second and first; wider than long, larger than the second, and pentagonal or hexagonal in form; each bearing on its outer sloping sides two series of tumid, stout alternating brachial pieces, directed horizontally outward, and in all but the two posterior rays, forming the base of two stout arms. In the posterior rays, intermediate brachial pieces are intercalated between the others so as to give origin in each of these rays to three arms, thus making twelve arms to the entire series.

First anal piece about as wide as long, heptagonal in form, with a flat surface entirely included within the concavity of the under side, supporting in the next range three pieces, which are longer than wide, and curve up so as to form a part of the outer wall, but are not included within the concavity of the under surface. Of these the lateral two have a general oval outline, with eight or nine sides and a tumid surface, while the middle one is hexagonal, moderately convex, and much narrower at the inner than the outer end. Above these are three other smaller pieces, connecting with the vault. First interradial pieces about once and a-half as long as wide, with nine sides, the inner half being flat and included within the concavity of the lower side, and the outer tumid. Connecting with the outer end of each of these are two elongated narrow pieces in the second range, which are usually tumid at the lower end, and extend up between the brachial pieces, to connect with the vault. Arms unknown.

Vault composed of irregular, unequal, tumid, larger and smaller pieces. Of the larger, more prominent pieces, one is situated over each ray, and another at the middle; while a series of four or five somewhat smaller pieces immediately surround the anterior and lateral margins of the middle one. The intermediate spaces are occupied by much smaller and less prominent pieces. Opening nearly over the posterior side, and penetrating a very prominent thickened ridge, which extends from the middle to the anal side, and is composed of comparatively large pieces for this part.

Surface of all the plates, including those of the vault, regularly granular. Column of moderate size, round, and composed near the base of alternately thicker and thinner pieces, with radiately striated surfaces, and perforated by a very small nearly rounded central canal.

Hight of body to top of vault, 0.88 inch; breadth, including three brachial pieces on each side, 1.13 inches; breadth of concavity of under side, 0.57 inch; thickness of column, 0.40 inch; from base, 0.17 inch.

This species differs from all the others yet known from the Burlington group, in having three arms to each posterior ray. It is most nearly allied to *A. bullatus*, Hall, a single individual of which, out of a considerable number in Mr. WACHSMUTH'S collection, has abnormally three arms in *one* of the posterior rays, all the others having two to each ray all around. It differs also from all of these, however, as well as from the original type now before us, in having the concavity of the under side less deep, and all the pieces surrounding it more tumid, while the form and proportions of its body pieces are different, its anal region much more protuberant, and its vault pieces less rounded and swelled. Its surface is also more coarsely granular.

Locality and position—Highest part of the upper bed of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 146 of Mr. WACHSMUTH'S collection.

GENUS TAXOCRINUS, Phillips, 1843.

TAXOCRINUS THIEMEI, Hall (sp.)

Pl. 4, Fig. 1.

Forbesiocrinus Thiemei, HALL. Desc. New Crin., Prelim. Note, p. 8, 1861.

(A perfect specimen of this beautiful species, showing the arms complete and about five inches of the column. Burlington limestone, Burlington, Iowa. Mr. WACHSMUTH'S collection.)

GENUS CYATHOCRINITES, Miller.

Cyathocrinites, MILLER, 1821. Nat. Hist. Crinoidea. p. 85; Quenst, 1835, Wegm. Arch. pp. 11, 89.*

AS properly restricted to true typical species, such as the *C. planus*, Miller, and *C. mammillaris*, *C. calcaratus* and *C. bursa*, Phillips, the genus *Cyathocrinites* includes forms with a more or less globose (or perhaps rarely obconic) body, composed of thin pieces, which below the vault consist of the basal, subradial and first radial plates, and but a single anal piece that can be properly regarded as forming a part of the walls of the body below the top of the first radials. Of true interradials there are apparently none. The base consists of five pieces, all normally of the same form, and alternating with these there are five generally larger subradials, one of which, on the anal side, differs in form from the others, being truncated above for the support of the only anal piece inserted between two of the first radials. The five first radial pieces are comparatively large, and alternate with the subradials all around.

The succeeding radials are all small, more or less rounded, or sometimes angular, and always free, or form no part of the walls of the body, those of each ray being distinctly separated by more or less wide interradial spaces. The number of these free pieces varies from two to some six or seven to the ray, the number being generally different in the different rays of the same individual. The arms are slender, more or less bifurcating and rounded, or sometimes angular, and always composed of a single series of pieces provided with a deep ambulacral furrow along the ventral or inner side, and apparently without tentacula (pinnulæ) along its margins. The column is generally, if not always round, and pierced by a small canal, and not divisible into five sections longitudinally.

The vault in this genus is always much depressed, never being extended upward in the form of a *large* poriferous trunk, or so-called proboscis, as we see in the typical forms of *Poteriocrinus*. It is very rarely preserved in the specimens as usually found, but according to PHILLIPS and AUSTIN'S figures of *C. planus* it would appear to be provided with a lateral proboscis, or more properly, as we think, anal tube, and an apparent central oral aperture. From specimens of *C. malvaceus* and *C. Iowensis*, however, which we have had an opportunity to examine in Mr. WACHSMUTH'S collection, and have described in another place, we are satisfied that in these species at least, which appear to be typical examples of the genus, the apparent central opening is closed by vault pieces in perfect specimens. These central pieces, however, are more liable to be removed by any accident than the five larger, surrounding pieces, because the latter are more deeply inserted, in order to permit the five rather large ambulacral canals extending inward from the arm-bases to pass *over* them, or rather along the upper side of the sutures between them, while these furrows pass in *under* the pieces forming the center of the vault, which are consequently less firmly fixed.

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* For a complete synonymy of this genus, see Vol. II, p. 175 of these Reports.

As we have not had an opportunity to examine the original typical specimens of *C. planus*, figured by PHILLIPS and AUSTIN, we of course cannot assert positively that the vault of these types was constructed like that of the Iowa species we have described, but we are strongly inclined to believe such was really the case, and that the apparent central opening was closed by vault pieces when the specimen was entire.

Of the American species presenting, so far as known, the characters of this genus as properly restricted, the following examples may be mentioned, though the vault of only the first two of these species is yet known to us, viz: *C. malvaceus*, Hall, *C. Iowensis*, Owen and Shumard, *C. (Poteriocrinus) Barrisi*, *C. viminalis*, *C. lamellosus*, *C. divaricatus* and *C. rotundatus*, Hall; also *C. Saffordi*, and perhaps *C. Farleyi*, M. and W., and *C. rigidus*, White.

CYATHOCRRINUS SCULPTILIS, Hall.

Pl. 4, Fig. 5.

Cyathocrinus sculptilis, HALL, Supp. Geol. of Iowa, p. 59.

(Burlington limestone, Burlington, Iowa.

CYATHOCRINITES FRAGILIS, M. and W.

Pl. 2, Fig. 14.

Cyathocrinites fragilis, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1868, p. 237.

BODY subsphæroidal, a little oblique, rather regularly rounded to the column below, from near the middle, and a little contracted above, composed of remarkably thin plates. Facet for the attachment of the column not excavated, and very small. Base having the form of a very shallow, subpentagonal basin; basal pieces with a general subquadrangular form, but really pentagonal from the slight truncation of their smaller inner ends at their connection with column. Subradial pieces comparatively large, hexagonal, excepting the one on the anal side, which is larger than the others, and heptagonal in outline. First radial pieces rather smaller than the largest subradials, somewhat wider than high, with a general subpentagonal form; all strongly incurved above between the free radials; facet for the reception of the second radials about one-third the breadth of the first radials, and rather deeply excavated. Anal piece rather smaller than the first radials, longer than wide, irregularly hexagonal, and supporting the outer side of the ventral tube (proboscis), which, like the body, is composed of very thin plates. Second (first free) radials very small, short, and not always extending entirely across the excavation for their reception; succeeding radials, excepting the last, quadrangular, as viewed on the outside, about twice as wide as long, and abruptly rounded or subangular on the outside; last one pentagonal, and generally a little longer than the others. Of these free radials four may be counted in one of the posterior rays, six in the other, three in one of the lateral rays, and seven in the anterior ray.

Arms at their origin on the last radials rather divergent, and in one of the posterior rays seen to bifurcate on the sixth piece, above which one of the divisions can be traced to the sixth piece without further bifurcation, though there are probably other divisions beyond; arm pieces about as long as wide, and, like those of the free radials, all deeper than wide, and profoundly grooved within for the reception of the ambulacral organs. Surface smooth or only very finely granular.

Hight of body, 0.50 inch.; greatest breadth of same, about 0.75 inch.

This species is related to *C. rotundatus*, Hall, but not only differs in having its free radial series much stouter (judging from the facets for their reception in the typical specimens of that species now before us), but in having all of its body plates very decidedly thinner, while its first radials also differ in curving strongly inward, between the bases of the free rays. It likewise comes from the lower division of the Burlington beds, while the *rotundatus* came from the upper, and it has been found that scarcely any of the species are common to those two horizons.

Locality and position—Burlington, Iowa; lower part of Burlington Limestone. Mr. WACHSMUTH's collection.

CYATHOCRINITES TENUIDACTYLUS, M. and W.

Pl. 2, Fig. 15.

Cyathocrinites tenuidactylus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1868, p. 238.

BODY, exclusive of the free rays, deeply cup-shaped, rounded below, composed of moderately thick plates for a true *Cyathocrinus*. Column comparatively rather stout, composed near the base of alternately thin and somewhat thicker pieces, the latter of which project a little, and seem to show a slight tendency to become minutely nodular; central canal distinctly pentapetalous in the form of its cross section. Base unknown, (being accidentally shoved into the body with the end of the column in the specimen studied). Subradials of moderate size, those seen hexagonal. First radials somewhat larger than the subradials, a little wider than long, with a general subpentagonal form; facet for the reception of the second radials about one-third as wide as the upper side of the plate, and excavated about one-third of the way down. Second radial pieces very small, wider than long, and with the succeeding radials curving outward. Third radial in one of the rays nearly as long as wide, expanded above and contracted below, and in this ray surmounted by a fourth, which, like the third in each of the only two other rays seen, is a triangular axillary piece, on which the arms rest, the upper angle being acute, and so produced as entirely to separate the arm bases, while the lateral slopes, on which the arms rest, are distinctly concave. Anal piece unknown.

Arms distinctly divergent at their origin on the last radials, as well as at their succeeding bifurcations, dividing on the third piece in two of the rays seen, and on the fourth in another, the pieces being rounded, nearly as wide as long, somewhat constricted in the middle, and a little dilated at their upper ends, while all of the axillary pieces at the various bifurcations have much the same form as the last free radials. Beyond the first bifurcations mentioned, above the last free radials, several of the arms are seen to bifurcate again on the fifth piece and twice to three times more at various distances above, while they all gradually decrease in thickness with each bifurcation until they become much attenuated, though the pieces of which they are composed maintain their length to such a degree that those of the smaller divisions are nearly twice as long as wide.

Surface of body plates slightly beveled at the sutures, and more or less roughened by small ridges or nodes, which on the subradial pieces present the appearance of nearly continuous, radiating, somewhat nodulous ridges, while those of the first radials have more the character of irregularly disposed nodes.

Length of the body below the top of first radial pieces, 0.40 inch; breadth of same about 0.64 inch; length of arms from their origin on the last radials at least 2 inches, and perhaps a little more.

This species seems to be more nearly allied to specimens in Mr. WACHSMUTH'S collection that have been identified with *Poteriocrinus Barrisi*, Hall, than to any other form with which we are acquainted. It differs entirely, however, in its sculpturing, that species having its body plates marked with numerous, rather fine, thread-like, radiating costæ. The arms, however, are more similar to those of our species, though they are rather stouter below in the latter.

We have not had an opportunity to see the type of *Poteriocrinus Barrisi*, but the form in Mr. WACHSMUTH'S collection, referred to that species by all the Burlington geologists, is a true *Cyathocrinus*, or more properly *Cyathocrinites*.

Locality and position—Lower division of the Burlington beds (Lower Carboniferous) at Burlington, Iowa. Mr. WACHSMUTH'S collection.

GENUS POTERIOCRINITES, Miller.

POTERIOCRINITES? PERPLEXUS, M. and W.

Pl. 2, Fig. 12.

Poteriocrinites? perplexus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 138.

BODY small, somewhat cup-shaped, with sides a little expanding above and rounding to the column below; hight to top of first radial pieces more than half the breadth at the same point. Base small, much depressed, or nearly flat, with a pentagonal outline. Subradial pieces each nearly as large as the whole base, about as wide as long, three hexagonal and two heptagonal (counting a very obtuse angle at the middle of the base of each.) First radials nearly twice as large as the subradial pieces, and proportionally wider, pentagonal in form, and each with a moderately deep, rounded sinus, rather more than half the breadth of its upper margin, for the reception of the succeeding radials. Anal pieces presenting the usual arrangement of a double alternating series, the lowest being partly under one side of the first radial on the right, while the next on the left of this rests on the truncated upper edge of one of the subradials, and these connect with others above, that form the base of the proboscidiform ventral extension. Second radials very small and short, or scarcely more than filling the sinuses in the first. Third radials nearly as wide as long, quadrangular, and only about half as wide as the first radials. Fourth radials a little larger than the third, pentagonal in form, and supporting the arms on their superior sloping sides.

Arms slender, rounded and proportionally long, bifurcating first above the last radial, generally on the third or fourth piece, above which each of the subdivisions bifurcate again several times. Arm pieces generally about as wide as long, and not wedge-shaped.

Proboscidiform extension at least half (and perhaps more than half) as long as the arms, entirely lateral, and not more than half as wide as the body, below; apparently somewhat thicker above. Body plates not convex, but merely granular, and joined by close-fitting sutures. Column slender, round, and composed of nearly equally moderately thick pieces, near the base.

Hight to top of first radial pieces, about 0.15 inch; breadth, 0.24 inch; length of arms, about 0.95 inch.

This is one of those few intermediate types such as we occasionally meet with in various departments of Natural History, when extensive collections can be studied—connecting, or standing, as it were, intermediate between two genera. That is to say, it combines some of the characters usually regarded as belonging especially to *Poteriocrinites*, with others equally characteristic of *Cyathocrinites*. Its body has much the usual form of *Cyathocrinites*, with the double alternating series of anal pieces precisely as we see in *Poteriocrinites*. On the other hand, it has the narrow, decidedly lateral proboscidiform ventral extension of *Cyathocrinites*, and might, with almost equal propriety, as far as we yet know, be called *Cyathocrinites? perplexus*. The existence of such a type would, in the estimation of some naturalists, be regarded as a sufficient reason for uniting the genera *Poteriocrinites* and *Cyathocrinites*. In this opinion, however, we cannot concur, for we believe that if all the genera thus connected by a few obscure forms were united, it would be found impossible to fix any limits whatever to such groups, with all the extinct types before us. Possibly characters may be found, however, warranting the establishment of a new genus for such forms.

Specifically, this little Crinoid seems to be most nearly allied to our *Cyathocrinus? enormis*, but it differs in the number and arrangement of its anal pieces, as well as in having its arm pieces scarcely one-half as long in proportion to thickness.

Locality and position—Lower part Burlington group of the Lower Carboniferous, Burlington, Iowa. No. 264 of Mr. WACHSMUTH's collection.

SUBGENUS SCAPHIOCRINUS, Hall.

SCAPHIOCRINUS DELICATUS, M. and W.

Pl. I. Fig. 5.

Scaphiocrinus delicatus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 144.

BODY very small, somewhat cup-shaped, once and a-half as wide as the hight to the top of the first radials; sides expanding rapidly upward from about the middle of the subradials to the top of the first radial pieces, and rounding under to the column below. Base very small, and nearly hidden by the column, pentagonal in general outline. Basal pieces merely appearing as minute trigonal facets around the top of the column, and curving upward a little at the extremity. Subradial pieces of comparatively rather large size, three or four of them hexagonal (counting a very obtuse angle at the middle of the under side), and one or two heptagonal. First radial pieces of about the size of the subradials, but shorter and wider, and all pentagonal in form; facet of each for the reception of the second radials not occupying the entire breadth above, and sloping outward. Second radials full twice as long as wide, measuring the breadth at the widest part of the lower end; slender and rounded in the middle, and enlarged at the ends, particularly below; each supporting two arms on their upper sloping sides.

Anal plates arranged in a double alternating series, exactly as in the last described species. Arms slender, rounded, and composed of joints, the lower of which are about twice as long as wide, but those above gradually growing shorter, until they become scarcely longer than wide, on the longer side; and owing to their oblique arrangement and projections for the support of the pinnulæ, presenting a zigzag appearance. At least one of the posterior arms seen to bifurcate on the seventh piece. Pinnulæ rounded, comparatively rather stout, composed of joints two or three times as long as wide, and owing to the length of the arm-pieces, widely separated from each other. Column of moderate thickness, and apparently showing a tendency to assume a pentagonal outline near the base.

Hight of body to the top of first radial pieces, 0.10 inch; breadth of do., 0.15 inch; length of arms, about 0.75 inch.

This very delicate little species is nearest like that we have already described under the name *S. nanus*, but will be readily distinguished by its much more slender second radial pieces and arms. This narrowness of the second radials causes the intervening spaces to be wider than the second radial pieces themselves; while in the *S. nanus* these pieces are so wide as to be in contact with each other all around, excepting on the anal side. These differences give to each of these two forms more strongly marked distinctive features than would probably be apparent from merely reading the descriptions without seeing the fossils themselves.

Locality and position—Upper division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 297 of Mr. WACHSMUTH'S collection.

SCAPHIOCRINUS CLIO, M. and W.

Pl. 1, Fig. 10.

Scaphiocrinus Clio, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 144.

BODY inversely subcampanulate, somewhat truncated or more or less rounded to the column below, and a little expanded at the top of the first radials, where it is nearly twice as wide as high. Base very small, or almost entirely hidden by the column, not projecting below the horizon of the next range of pieces. Subradial pieces slightly tumid, and owing to the small size of the base forming most of the under side, as well as half of the hight of the body, a little longer than wide, and all (excepting probably one or two not seen on the anal side) presenting a general pentagonal outline, there being no visible angle at the middle of the under side in any of them. First radials larger than the subradials, wider than long, pentagonal in form, and rounded or convex on the outer side above. Second radials short, transversely oblong, or about twice as wide as long, and all rounded on the outer side. Third radials (in four of the rays seen) somewhat longer than the second, pentagonal in form, but with their lateral margins so short as to appear nearly trigonal; supporting the arms on their superior sloping sides. Anal pieces unknown.

Arms round, rather slender, and after their origin on the third primary radials, bifurcating on the seventh, ninth or eleventh pieces in the different arms seen, and beyond this, one arm is observed to bifurcate on the nineteenth piece above; all composed of slightly wedge-formed pieces, a little wider than long.

Proboscis (so-called), as observed nearly flattened by pressure, two-thirds as wide as the body, and about four-fifths as long as the arms; not expanded at the summit; composed of moderate sized hexagonal pieces indented (and probably perforated) at the corners. Column sub-pentagonal near the base, where it is composed of alternately thicker and thinner pieces, with a small apparently pentagonal canal.

Hight of body to top of first radials, 0.20 inch; breadth, about 0.40 inch; length of arms, about 2.10 inches. Length of proboscis above first radials, 1.70 inches; thickness of column at its connection with the base, 0.15 inch.

This species is related to such forms as *S. carinatus* and *S. dichotomus*, Hall; *S. rusticus*, White, and *S. Wachsmuthi*, M. and W., but differs from them all too clearly to render a comparison necessary.

Locality and position—Upper division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 295 of Mr. WACHSMUTH'S collection.

SCAPHIOCRINUS NOTABILIS, M. and W.

Pl. 1, Fig. 9.

Scaphiocrinus notabilis, MEEK and WORTHEN. Proceed. Acad Nat. Sci., Phila., 1869, p.148

BODY large, obconic, or expanding gradually from the column to the middle of the first radials, at which point these pieces are protuberant, so as to give the general outline (as seen in a side view) a tendency towards an inverted bell-shape. Base of a deep cup-form, less than twice as wide at the top as the hight, or about one-third as high as the body to the top of the first radials. Basal pieces higher than wide, and pentagonal in form, the lateral margins being longest. Subradial pieces nearly twice as long as the basal, hexagonal in form, excepting the two on the anal side, which are heptagonal. First radials somewhat larger than the subradial pieces, slightly wider than long, pentagonal in form, and each provided with a very profound sinus for the reception of the second radials, more than one-third as wide as its upper edge, and extending about half way down its outer side. Second radial pieces comparatively very small, or about one-third as large as the first; pentagonal in form, about as wide as long, rounded on the outer side, and so deeply inserted in the sinus of the first radials on a kind of shoulder-like projection, that their mesial angle above scarcely rises beyond the upper margins of the first radials, each supporting two arms on its superior sloping sides, and separated from that of the next ray on each side, by an interradial space of about once and a half its own breadth. Anal plates two and about half of the third, included as a part of the walls of the body, hexagonal in form, and having the usual arrangement of those *Poteriocrinites*, in a double, vertical, alternating series.

Arms very long, slender and rounded; one of them seen to bifurcate first on the sixth, two others on the eighth, and another on the tenth piece, above the second radials.

Beyond these bifurcations, it is evident from the number of slender branches seen that there must be other subdivisions, but the specimen is not in a condition to show the details of the bifurcations. Arm pieces generally longer on the longer side than wide, but not arranged in zigzag; the first two of each arm twice as long as wide, and somewhat contracted around the middle. Proboscidiform extension very long, or nearly or quite equaling the length of the arms, and somewhat narrowed at the extremity.

Surface of the first radial plates strengthened by prominent, rounded, radiating costæ, two of which diverge downward from the mesial prominence under the sinus for the second radials, to connect with others on the subradials, so as to inclose profound triangular pits at the upper corners of the latter; while two similar ridges run laterally on each side of the sinus, parallel to the upper margin, to connect with those similarly situated on each adjacent first radial. On each subradial the ridge extending down the middle widens, and becomes nearly obsolete at the base, where it connects with several slender lines that continue on down, converging toward the lower part of each basal piece; there being no pits or impressions at the meeting of the corners of the basal and subradial pieces.

Hight of body to the top of the first radial 0.96 inch; breadth across at the most protuberant part of the first radials, about 1 inch; length of arms from their origin on the second radials, about 4 inches; length of proboscidiform ventral extension, 3.85 inches.

This fine species departs very widely from the typical forms of *Scaphiocrinus* in its large size, obconic body, strongly costate body plates, long bifurcating arms, and particularly in having its second radial pieces so narrow, in proportion to the first, as to be separated from each other by interradial spaces wider than the second radial pieces themselves. Its anal series, although including more pieces than we see in the *typical Scaphiocrinus* (being like that of *Poteriocrinites* proper), does not differ from that of a large proportion of the species usually included in *Scaphi-*

ocrinus, with which the species agrees in having only two radial pieces to each ray.

Specifically it is related to such forms as *Cyathocrinus macropleurus*, Hall, and *Poteriocrinus obuncus*, White; but it differs too widely from these and all other similar forms known to us to render a comparison necessary. *Cyathocrinus macropleurus* was described from a specimen not showing either the anal pieces or second radials, or the arms. Mr. WACHSMUTH has specimens, however, showing that it has several anal pieces, and two radials to each ray. He also has specimens of the *P. obuncus* (which was also described from a specimen not showing the arms and second radials), indicating that it agrees in these characters with *Scaphiocrinus*. It is possible such species should form a separate section or subordinate group.

Locality and position—Lower division of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 303 of Mr. WACHSMUTH'S collection.

SCAPHIOCRINUS RUDIS, M. and W.

Pl. 1, Fig. 1.

Scaphiocrinus rudis, MEEK and WORTHEN. Proceed. Acad. Nat. Sci. Phila., 1869, p. 139.

BODY much depressed, about four times as wide as high, flat or a little concave below, the flattened part including the basal, subradial, and about half the length of the first radial pieces. Base very small, a little impressed, and entirely hidden by the column. Subradial pieces of moderate size, extending out horizontally from the column; the one on the anal side, however, curving up distinctly, and the others slightly, at the ends; all flat, excepting the curvature mentioned, and pentagonal in outline (the superior angle being rather salient), excepting the one on the anal side, which is hexagonal, being truncated above for the reception of the anal piece. First radial pieces three or four times as large as the subradials, twice as wide as long, very tumid in the middle, and pentagonal in form, the lateral margins being longer than the inferior, and the superior one straight, and equaling the entire breadth. Second radial pieces of about the same size as the first, which they equal in breadth below, though they are a little longer, and proportionally narrower above, and have each a strong angle down the middle of the outer side; all pentagonal in outline (excepting the anterior one, which is quadrangular), the superior angle being salient, each supporting two arms on the superior sloping sides, excepting the anterior one, which bears but a single arm.

Of anal pieces one only is included as a part of the walls of the body, and this one rests upon the upper truncated edge of the largest curved subradial, and connects on each side with a first radial. Succeeding anals unknown.

Arms moderately strong, simple, angular on the dorsal side, and composed of short wedge-shaped pieces, alternately projecting out laterally on each side, in the form of spine-like processes. Column small, round, and composed near the base of pieces of moderate thickness, with each a projecting ridge around its middle, and perforated by a minute round canal. Sutures between the first and second radial pieces widely gaping when the arms are folded up vertically.

Hight of body, 0.08 inch to top of first radials; breadth, 0.33 inch; length of remaining portions of arms, about 0.85 inch; thickness of column at base, 0.17 inch.

This belongs to the typical section of *Scaphiocrinus*, as it has but a single anal piece included as a part of the body, and all its arms are simple. Specifically it appears to be most nearly allied to *S. spinobrachiatus*, Hall (Bost. Jour. Nat. Hist., vol. vii, p. 306), but differs in having its body much depressed. more flattened below, and its base is so much smaller as to be entirely hidden by the column, instead of projecting out around it. Its subradial pieces also differ in not being more elevated than the others, nor impressed at the angles. The arms in the specimen from which our description was drawn up, are not quite complete at their ends, though from a slight tapering, and appearance of a tendency to curve together toward their extremities, it seems to be quite probable that they were not more than an inch in length, while those of the species *spinobrachiatus* are said to be about three inches in length, in the original specimen, and still imperfect at the ends.

Locality and position—Upper division of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 275 of Mr. WACHSMUTH'S collection.

SCAPHIOCRINUS PENICILLUS, M. and W.

Pl. 2, Fig. 7.

Scaphiocrinus penicillus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 142.

BODY small, somewhat basin-shaped, or about three times as wide as the hight to the top of the first radial pieces, truncated, and a little concave below. Base very small, and nearly or quite hidden by the column in the shallow concavity of the under side. Subradials generally wider than long, with a pentagonal outline, excepting one on the anal side, which has the upper angle a little truncated, so as to make a sixth angle; there is doubtless also another obtuse angle at the middle of the lower side of each, covered by the column. First radial pieces wider than high, and pentagonal in form. Second radial pieces nearly twice as long as wide, expanded at each end, and distinctly constricted along the middle, where they are each somewhat carinated on the dorsal side; all pentagonal in form and supporting each two arms on their superior sloping sides, excepting in the anterior ray, where this piece is quadrangular and supports but one arm.

First anal piece wedged obliquely down in between two of the subradials, under one side of the first radial, on its right, and connecting by its left side, above the middle, with another anal resting on a very short truncated side of one of the subradials, and connecting on the left with the first radial of that side. Above these one or two other pieces are seen between the arms, connecting with the base of the proboscis.

Arms somewhat rounded, and bifurcating on the fifth or sixth piece above the second radials; and in all but the anterior ray, one of the divisions (the inner one) remains simple, and the other subdivides again on the sixth, seventh or eighth piece, while the anterior arm bifurcates first on the sixth piece, and each of its subdivisions again on the eighth or tenth piece above. First, and sometimes also the second arm pieces a little longer than wide, and slightly constricted; other arm pieces generally wider than long and wedge shaped, but not arranged so as to impart a zigzag appearance to the arms. Column small, nearly or quite round, and composed near the base of alternately thin and thick pieces.

Hight of body to top of first radial pieces, 0.07 inch; breadth, 0.20 inch; length of arms, about 0.70 inch.

This little species seems to be nearest like *S. dichotomus*, Hall, (Iowa report, p. 553), with which it agrees in size and general appearance. It will be readily distinguished, however, by the more frequent bifurcations of its arms, which also differ in being more rounded and composed of proportionally longer pieces, not arranged so as to present a slightly zigzag appearance, as in the species *dichotomus*. It will also be distinguished from the last by having two arms to each ray all around, as well as by its concave base.

Locality and position—Upper division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 286 of Mr. WACHSMUTH'S collection.

SCAPHIOCRINUS MACRODACTYLUS, M. and W.

Pl. 2, Fig. 9.

Scaphiocrinus macrodactylus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 140.

BODY obconical, or tapering rather gradually from the top of the first radials to the column. Base about twice as wide at the top as long, truncated below the breadth of the column; basal pieces a little longer than wide, pentagonal in form, with the lateral margins longer than the upper sloping sides. Subradial pieces once and a half to twice the size of the basals, hexagonal in form, excepting one (or possibly two) on the anal side, which is larger than the others and pentagonal, being truncated above for the reception of an anal piece. First radial pieces wider and a little shorter than the subradials, and all wider than long. Second radials distinctly longer than wide, rounded and constricted in the middle, with a pentagonal outline (excepting the one in the anterior ray, which is truncated above,) and supporting the arms on their superior sloping sides. Arms nine or ten, simple from their origin, very long, slender, rounded and composed of wedge-form pieces, which have their longer side about twice the length of the shorter, and equaling their breadth, but not projecting so as to give the arms a zigzag appearance. Pinnulæ long, moderately stout, and composed of joints about twice as long as wide. Anal pieces unknown.

Surface finely granular. Column round, moderately stout and composed of rather thin pieces, of uniform size near the base, with a rather small, round or subpentagonal central canal.

Length of body below the summit of the first radial pieces, 0.40 inch; breadth, about 0.50 inch; diameter of column at base, 0.18 inch; entire length of arms unknown, as they are all broken at the extremity, with the remaining portion measuring 3.40 inches in length, with thickness of about 0.10 inch throughout.

This species has the long, straight arms, obconic body, protuberant base, and general physiognomy of the typical forms of *Poteriocrinites*, but differs in having but two primary radial pieces to each ray, with the sutures between them somewhat gaping, as in *Scaphiocrinus*. Specifically it is not closely allied to any of the other known species. In the form of its body it is most nearly allied to our *Pot. subimpressus*, which, Mr. WACHSMUTH has ascertained, probably has only two primary radial pieces to each ray, and hence seems to fall into *Scaphiocrinus*, giving that group the wide limits usually admitted. The species here under consideration, however, will be readily distinguished from the *Pot. (Scaph.) subimpressus*, by not having its body plates impressed at the corners, and all distinctly thinner, as well as by its less robust general habit.

Locality and position—Lower beds of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 277 of Mr. WACHSMUTH'S collection.

SCAPHIOCRINUS JUVENIS, M. and W.

Pl. 2, fig. 8.

Scaphiocrinus juvenis, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 146.

BODY small, expanding rather rapidly from the column, or presenting a short, obconic form, with rather distinct sinuses between the radial series; nearly twice as wide at the top of the first radials as the hight to the same point. Base small and short, or several times wider than high, but projecting below the subradials, truncated about three-fourths its breadth by the facet for the attachment of the column. Basal pieces nearly twice as wide as long, and pentagonal in form, but owing to the shortness of the lateral margins, appearing nearly trigonal. Subradial pieces a little wider than long, three pentagonal, and two on the anal side hexagonal (without counting a scarcely defined angle at the middle of the under side of each). First radial pieces of about the size of the subradials, generally wider than long, and pentagonal in form. Second radials about as long as wide, distinctly rounded on the dorsal side, and quadrangular in outline. Third radials somewhat larger than the second, more or less expanded at the upper end, and rounded and contracted in the middle; each bearing two arms on its superior sloping sides.

Anal plates forming a double alternating series of five or six pieces, as in the last; the lowest piece resting between the upper sloping sides of two of the subradials, partly under the first radial on the right, and connecting on the left above the middle, with another piece resting upon the upper truncated edge of one of the subradials, and joining the first radial on the left.

Arms ten, simple from their origin on the third radials, composed of somewhat wedge-formed pieces, about as long as wide on the longer side, which projects above, alternately on opposite sides of the arms, for the reception of the pinnulæ, so as to present a somewhat zigzag appearance.

Pinnulæ stout, arranged at intervals of near their own breadth apart, and composed of joints that are about as long as wide. Surface granular; body plates even, and merely separated by linear sutures. Column of comparatively moderate size, faintly subpentagonal near the base, and composed of rather thin, nearly equal plates, with a very small central perforation.

Hight of body to the top of first radial pieces, about 0.12 inch; breadth, 0.20 inch; length of arms, about 0.75 inch; thickness of column at base, near 0.07 inch.

This species is related to the last two, but is readily distinguished by the more conical form of its body, produced by the protuberance of its base, as well as by having two arms to each ray all around, instead of only one in the anterior ray. It also differs from both in having its body plates even, instead of very convex, or tumid, as in *S. scalaris*, or costate, as in *S. fiscellus*.

Locality and position—Lower division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 284 of Mr. WACHSMUTH'S collection.

SCAPHIOCRINUS STRIATUS, M. and W.

Pl. 2, Fig. 11.

Saphiocrinus striatus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 142.

BODY below the top of the first radial pieces subhemispherical, being regularly rounded below; composed of thick plates, which are ornamented with distinct, somewhat broken striæ, running vertically, so as to radiate from the base, but all parallel with each other on each individual plate. Basal pieces hidden by the column externally. Subradials about as wide as long, five of them showing a pentagonal outline (there being no visible angle at the middle of their bases on the outside), and one on the anal side hexagonal, the latter being a little larger than the others. First radial pieces slightly shorter than the subradials, but about once and a half as wide, all having a general pentagonal form, being broadly truncated their entire breadth above, and having the articulating surfaces each marked with two very distinct transverse furrows. First anal piece a little longer than wide, hexagonal in form, and resting upon the truncated upper end of the odd subradial between two of the first radials, beyond which it projects nearly half its length; truncated above for the reception of a second anal. Other parts unknown.

Sutures distinctly channeled, so as to impart a moderate convexity to the plates.

Hight to top of first radials, 0.20 inch; breadth, 0.46 inch.

This is a typical *Scaphiocrinus*, as far as its parts are known, and seems to be most nearly related to *S. simplex*, of Hall, from which it may be at once distinguished, however, by its channeled sutures, convex plates and peculiar sculpturing.

Locality and position—Lower Burlington beds, of the Lower Carboniferous, at Burlington, Iowa. No. 274 of Mr. WACHSMUTH'S collection.

SCAPHIOCRINUS TETHYS, M. and W.

Pl. 2, Fig. 13.

Scaphiocrinus Tethys, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 143.

BODY under medium size, expanding rather rapidly from the column to the top of the first radials, where it is about one-fourth wider than high. Base small, twice to three times as wide as high. Basal pieces very small, wider than high, and pentagonal in form. Subradial pieces slightly wider than long, pentagonal, excepting two on the anal side, which are hexagonal, there being no well defined angle at the middle of the base of any of them. First radials larger than the subradials, a little wider than long, and all pentagonal. Second radial pieces rather more than twice as wide as long, rounded and a little constricted in the middle, and somewhat expanded at the ends; all pentagonal in outline, and each supporting two arms on its superior sloping sides.

Anal series consisting of two alternating vertical ranges of pieces, the first of which rests between the two upper sloping sides of two of the subradials, and supports an inferior sloping side of the first radial on the right, while its left side above the middle connects with another anal resting upon the truncated upper side of one of the subradials, and connecting with the first radial on the right. Above these one or two ranges of similar pieces join with those forming the base of the so-called proboscis.

Arms not positively known to bifurcate after their origin on the second radial pieces; composed of joints, the lower of which are twice to three times as long as wide, and rounded or subangular, and narrower in the middle than at the ends. Above these the pieces gradually become shorter, and more distinctly expanded at the ends, with the upper lateral extremity of each somewhat projecting alternately on opposite sides, so as to present a distinct zigzag arrangement, the projection being for the support of the pinnulæ, which are comparatively rather stout, and composed of joints two or three times as long as wide, and provided with deep ambulacral furrows within.

Column comparatively rather stout; subpentagonal near the base, but soon tapering and becoming rounded below; composed below of uniform pieces; about one-third as thick as wide, but gradually becoming thinner near the base of the body.

Length of the body to top of first radial pieces, 0.17 inch; breadth about 0.22 inch; length of arms, about 1.10 inch.

This species is related to that we have here described under the name *S. nanus*, but not only differs in having longer arms, but in having its second radial pieces and all of its arm joints much longer in proportion, as well as presenting a more strongly zigzag arrangement. Its base is also more protuberant, and the sutures between its body plates slightly impressed instead of even.

Locality and position—Upper division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 298 of Mr. WACHSMUTH'S collection.

SCAPHIOCRINUS SCALARIS, M. and W.

Pl. 2, Fig. 10.

Scaphiocrinus scalaris, MEEK and WORTHEN., Proceed. Acad. Nat. Sci., Phila., 1869, p. 145.

BODY small, somewhat cup-shaped, being broad below, and a little expanded above; about twice as wide as high at the top of the first radials. Base small and hidden by the column in the concavity of the under side. Subradial pieces tumid, wider than high, and arranged so that the body rests upon them, when placed on a plane surface with the column removed; all appearing as if pentagonal, excepting the two on the anal side, which seem to be hexagonal, but they must all have each an additional obtuse angle at the middle of the under side. First radials about of the same size as the subradials, wider than long, and pentagonal in form, though one on the anal side has one side so short as to appear as if quadrangular; each a little expanded above, so as to present, with the broad excavations at their inferior lateral angles, a more or less constricted appearance. Second radials smaller than the first, rounded on the outer side, and a little constricted on the lateral margins, all wider than long, with a quadrangular outline. Third radial pieces, in all but the anterior ray, nearly as large as the first, but proportionally longer, rounded on the outer side, constricted in the middle, and pentagonal in form; the superior lateral sloping sides of each supporting an arm. In the anterior ray the third piece is narrow and long, truncated above, and merely supports a single arm.

First anal piece smaller than the subradials, pentagonal in form, and resting between the upper sloping sides of the two hexagonal subradials; connecting on the left with the second anal, and on the right with a first radial, while it supports one side of another anal above. Second anal of nearly the same size as the first, and resting upon the superior truncated side of the subradial below. Above these, two alternating series of anal pieces are seen extending upward, to connect with the base of the so-called proboscis.

Arms nine, simple from their origin on the third radials, rather angular on the back, and each composed of short wedge-formed pieces, arranged somewhat in zigzag, with their longer ends alternately on opposite sides, and projecting so as to support stout, rounded pinnulæ, composed of joints sometimes nearly as long as wide. Pinnulæ very regularly arranged, so as to leave intervening spaces scarcely of their own breadth, and so stout as to present rather the appearance of armlets, than what are usually called tentacles, in the descriptions of fossil Crinoids; all like the arms with the ambulacral furrows comparatively deep and large.

Vault unknown; proboscis (so-called) about half as long as the arms, comparatively rather slender until at the upper extremity, where it is suddenly expanded to nearly twice its breadth below, and somewhat flattened on top. The expansion, however, seems to be mainly due to the greater thickness of the plates here than to a corresponding increase in the size of the cavity within. Plates of the proboscis of moderate size, and all indented at their corners.

Hight of body to the top of first radial pieces, 0.18 inch; breadth about 0.32 inch; length of arms beyond the top of the third radials, 1.68 inches; length of proboscis above the first radials, 0.95 inch.

This species is so distinct from all others known to us that it is scarcely necessary to compare it with any of them. It seems to be most like *S. Halli*, Hall, but differs in having its subradials so tumid as to give the body a truncated appearance below, instead of an inversely campanulate outline. Its pinnulæ are also much stouter and less oblique, while its arms are entirely without the little flattened spine-like projections along their backs seen in that species. The stout pinnulæ as seen extending between the arms present, with the latter, a peculiar scalariform appearance that suggests the specific name.

Locality and position—Upper division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 282 of Mr. WACHSMUTH'S colection.

SCAPHIOCRINUS NANUS, M. and W.

Pl. 1, Fig. 8.

Scaphiocrinus nanus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 141.

BODY very small, expanding rapidly from the column to the top of the first radials, where it is about once and a half as wide as high. Base small, slightly projecting, pentagonal in outline, and nearly covered by the round, flat facet for the attachment of the column. Basal pieces showing a very short, minute pentagonal facet above the column. Subradial pieces a little wider than long, three with a pentagonal outline, and two on the anal side, hexagonal, there being no well defined angle visible at the middle of the under side of any of them. First radials about the size of the subradial pieces, a little wider than long, pentagonal in form, and somewhat rounded on their outer sides, in consequence of the sutures between them being impressed. Second radials longer than wide, or nearly twice as long as the first, all pentagonal in outline and rounded and more or less constricted in the middle, each supporting two arms on its upper sloping side.

Anal pieces consisting of a double alternating series, the lowest one of which rests between the upper sloping sides of two of the subradials, and supports one side of the first radial on the right, while on its left it connects above the middle with another anal resting upon the truncated upper side of one of the subradials, and connecting on its left with the first radial on that side; above these three or four other pieces are seen between the arms extending up and joining with the base of the so-called proboscis.

Arms somewhat rounded on the dorsal side, each bifurcating on the sixth or seventh piece above the second primary radials, and composed of wedge-formed pieces that are a little longer than wide on the longer side. Above the bifurcations these pieces are somewhat constricted, and each one projecting laterally above on its longer side, for the reception of the pinnulæ, so as to present a rather zigzag appearance. Pinnulæ moderately stout, and rather distantly separated from each other; composed of joints a little more than twice as long as wide.

Surface of body plates even, and finely granular.

Hight of body, 0.10 inch to top of first radial pieces, where it measures about 0.20 inch in breadth; arms, about 0.75 inch in length.

In size and general appearance this species is quite similar to *S. dichotomus*, of Hall, with which it also agrees in having its arms bifurcating but once above their origin on the second radials. It differs, however, in having its second radial pieces rounded instead of angular, and distinctly longer in proportion to breadth, as is also the case with all the arm joints. It also differs in having two arms to each ray, all around, instead of only one in the anterior ray, as well as in the number of pieces in each arm below the bifurcations. Its arms are likewise proportionally more slender.

Locality and position—Lower division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. Mr. WACHSMUTH'S collection.

SCAPHIOCRINUS FISCELLUS, M. and W.

Pl. 1, Fig. 3.

Scaphiocrinus fiscellus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 146.

BODY very small, somewhat cup-shaped, about once and a half as wide as high, rather broad and subtruncated below, with moderately expanded sides. Base very small, flat, and hidden by the column, when the latter is attached. Subradial pieces convex, curving under to connect with the base, and extending about half way up the sides; three of them presenting a pentagonal outline, and two hexagonal, (that is without counting a very obtuse angle, doubtless existing at the middle of the under side of each, but hidden by the column). First radials about the size of the subradial pieces, and pentagonal in form, the upper side always truncated the full breadth. Second radials quadrangular, constricted in the middle, and expanded at the ends; separated from each other by spaces nearly half their own breadth, measuring at the middle. Third radial pieces a little longer and narrower than the second, abruptly dilated at the ends, and strongly contracted in the middle; each with apparently the exception of one in the anterior ray (which seems to bear only one arm), supporting two arms on their superior strongly sloping sides.

Anal plates forming a double alternately arranged series, exactly as in *S. scalaris*. Arms apparently simple from their origin on the third radials; composed of pieces as long as wide, or a little longer, and angular on the dorsal side; each piece always contracted in the middle, and expanded at the ends, particularly at one of the upper lateral corners alternately on each side of the arm, for the reception of the pinnulæ, thus giving the arms a zigzag appearance. Pinnulæ rather stout, and composed of pieces about as long as wide.

Surface of the body with deep indentations at the corners of all the plates, so as to form a comparatively strong ridge radiating to each side of the subradial pieces, to connect with a similar one on each of the adjacent pieces.

Hight of body about 0.11 inch to the top of the first radial pieces, where it measures about 0.17 inch in breadth; length of arms, about 0.95 inch.

This species is nearly related to *S. scalaris*, but in addition to being much smaller, it differs in the strong radiating costæ of its body plates, as well as in having its subradial plates merely convex, instead of tumid. Its arm joints also differ in being proportionally longer, and contracted in the middle.

Locality and position—Lower division of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 283 of Mr. WACHSMUTH'S collection.

SUBGENUS ZEACRINUS.

ZEACRINUS SCOBINA, M. and W.

Pl. 1, Fig 2.

Zeacrinus scobina, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 149.

BODY very much depressed, or about four times as wide as high, to the top of the first radial pieces, and concave in the middle below. Base small, and hidden by the column in the concavity of the under side. Subradial pieces curving in to the concavity of the under side, and extending outward around the column; all presenting a nearly pentagonal general outline, with short lateral edges, excepting the one on the anal side, which seems to be hexagonal, (each being without a visible angle at the middle of the under side.) First radials three or four times as large as the subradials, near twice as wide as long, pentagonal in form, with lateral and inferior margins of nearly equal length, and upper edge equaling the entire breadth. Second radials as wide as the first, and nearly twice as long, all pentagonal in form, the superior angle being salient, and also projecting outward, while a strongly defined mesial angle extends down the middle of the dorsal or outer side to the base of each, the surface on each side of this angle being distinctly concave.

Anal pieces small, and owing to the rough surface of the plates, and the indistinctness of the sutures, without very clearly defined outlines. As near as can be made out, the first one seems to be somewhat cuneiform, and wedged in obliquely under one side of the first radial on the right; on its left it connects above the middle, apparently with another resting upon a very short upper side of one of the subradials. Above these other anal pieces are seen between the arms, but their exact arrangement cannot be made out from the specimen studied.

Arms, after their origin on the second radials, each bifurcating on the sixth piece (excepting those of the anterior ray, which divide first on the eleventh piece), the inner division of each being smaller than the other, and remaining simple; while the outer or main arm gives off another division on the inner side on the eighth piece above the first bifurcation, and still another on the ninth or tenth piece above the latter, which is as far as the arms can be clearly traced in the specimen, though there is some appearance of a fourth bifurcation in one of the arms. Arm pieces short, or from twice to three times as wide as long, and not in the slightest degree wedge-shaped; each with lateral edges sharp and a little projecting, and provided with a little pointed process on the middle of the dorsal side. These little asperities, and the beveled character of the sutures between the arm joints, give the arms a rough, rasp-like appearance, which has suggested the specific name. The body plates are also rendered very rough by a ridge extending from the middle of the upper edge of each first radial to connect with others on the subradials, and the presence of other irregular asperities. Sutures between the first and second radials widely gaping when the arms are folded together. Column of moderate size, and composed of thin, nearly round pieces, with projecting rough edges, and a rather small subpentagonal central perforation.

Hight of body to the top of the first radials, 0.10 inch; breadth, about 0.42 inch; length of arms, about 1.70 inches.

This species is related to *Zeacrinus perangulatus*, of Dr. White, but differs in having its arms longer and less tapering, as well as bifurcating more frequently; also in having each inner division of each arm smaller than the outer. The bifurcating pieces of its arms are likewise proportionally smaller, and not protuberant as in that species. In the species *perangulatus* the arm pieces are also merely angular along the middle, while in that under consideration there is, instead of a continuous angle, a row of little pointed isolated protuberances, presenting a crenate appearance as seen in outline.

Locality and position—Upper division of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 321 of Mr. WACHSMUTH'S collection.

ZEACRINUS SERRATUS, M. and W.

Pl. 1, Fig. 6.

Zeacrinus serratus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 151.

BODY small, much depressed, or about three times as wide as high, broadly truncated and concave below. Base very small, and nearly or quite concealed by the column in the concavity of the under side. Subradials a little tumid, curving abruptly into the concavity of the under side, and extending about half way up the lateral walls of the body; three or four pentagonal and one or two on the anal side hexagonal (not counting a very obtuse angle doubtless existing at the middle of the under side of each.) First radials somewhat larger than the subradials, nearly twice as wide as high, and all pentagonal in form, with the upper side equaling the entire breadth. Second radials as wide at the base as the first, and nearly twice as long, each pentagonal in form, and supporting two arms, excepting that of the anterior ray, which is quadrangular, and supports but a single arm; each with a prominent, well defined, sharp carina extending up the middle, and the dorsal surface on each side of this carina is distinctly concave. Anal pieces arranged in a double alternating series almost exactly as in the last.

Arms (excepting in the anterior ray) bifurcating first on the sixth piece above their origin on the second radials, the inner division being slightly smaller than the other, and simple to the end, while the outer division bifurcates again on the seventh piece above, and a third time on the eighth piece above the latter, the inner divisions being all simple. Arm pieces very short, or two or three times as wide as long, and scarcely showing any tendency to assume a wedge-shaped outline; each one with a small pinched or angular projection on the middle of the dorsal side, giving the arms a subcarinated appearance; but these projections are not continuous, being separated by notches at the sutures between the pieces, and a little inclined upward, so as to impart to the dorsal side of the arms a serrated appearance, as seen in an outline lateral view. Axillary pieces at all the bifurcations of the arms larger than the other arm pieces, and more prominent and angular.

Surface of body plates nearly convex, or somewhat tumid, and without costæ or carina. Column very small, round or subpentagonal, and composed near the base of nearly equal, rather thin pieces, with a very minute central perforation. Sutures between the first and second radial pieces widely gaping.

Hight of body, 0.07 inch; breadth, about 0.22 inch; length of arms, about 0.60 inch.

In several respects this species agrees almost exactly with *Z. ramosus*, of Hall, which has the same proportions, with its arms bifurcating in exactly the same way, and composed of similar short pieces, showing no tendency to a wedge-formed outline. On comparison with the original typical specimen of that species, however, now before us, the species under consideration is found to differ in having its second radial pieces each provided with a sharp, strongly defined mesial carina, and the surface on each side of the carina distinctly concave, instead of having these pieces merely obtusely rounded. The same or a similar difference is also seen in the arm pieces, each of which is provided with one or more little projections on the dorsal side, instead of being smoothly rounded or somewhat flattened, as in *Z. ramosus*. If it were not for the fact that the typical specimen of *Z. ramosus* has the surface well preserved, we would be led to think it might possibly have possessed the sharp carina of the second radials, and the projecting points of the arm pieces, seen in the species under consideration, and that they might have been removed by accidental abrasion. The fact, however, that it has the surface of its arms, second radials and other parts so well preserved as to show the original fine, delicate granulations over the whole, demonstrates that it could never have possessed the characters mentioned in the species we have here described; and as we have never seen varieties of a species, in this or any of the allied groups, differing to this extent in such characters, we can but regard the difference as being specific.

It will be observed that the character of the arm and second radial pieces mentioned as distinguishing this species from *Z. ramosus*, also occur in the species described in this paper under the name of *Z. scobina*. That species, however, differs from this in having its first radials and subradial plates strongly costate, while its arms are proportionally longer, and differ in being somewhat serrated on each side. It also differs in having two arms, instead of only one, from the anterior ray, as in this, and more divisions in its arms, which divisions are given off at greater intervals.

Locality and position—Burlington group, at Burlington, Iowa. Lower Carboniferous. Mr. WACHSMUTH'S collection.

ZEACRINUS ASPER, M. and W.

Pl. 1, Fig. 7

Zeacrinus asper, MEEK and WORTHEN. Proceed Acad. Nat. Sci., Phila., 1869, p. 150.

BODY small, much depressed, or twice and a-half as wide as high, broadly truncated and concave below, the concavity including the base and about half the length of each subradial piece. Base small and nearly or quite hidden by the column. Subradial pieces very abruptly geniculated in the middle, the lower or inner half forming a part of the concavity of the under side, and the upper a part of the outer wall of the body, while their prominent middle forms the margin of the concavity below, each presenting a pentagonal outline, excepting one on the anal side, which is hexagonal. First radial pieces about twice as long as the subradials, and twice as wide as long, all pentagonal in form, with the upper truncated side equaling the full breadth. Second radial pieces as wide, and once and a-half as long as the first, pentagonal in form (unless the anterior one, which has not been seen, may be an exception), and supporting the arms on their superior sloping sides, each with a very prominent sharp carina extending up the middle, while the surface on each side of the carina is deeply concave, excepting at the lower margin, along which there is also a transverse ridge or carina.

Anal plates arranged as in the last described species, in a double alternating series, the lower one being placed obliquely under one side of the first radial on the right, while the next rests upon a short end of one of the subradials, the two connecting together and supporting the others above.

Arms, after their origin on the second radial pieces, each bifurcating on the sixth piece, the two divisions of each being of equal size, but the inner one is simple, while the outer bifurcates again on the sixth, seventh, eighth or ninth piece above the first division, beyond which the two equal divisions are simple as far as they can be traced in the specimens examined. Arm pieces short, or nearly twice as wide as long, wedge-form, and each strongly projecting on the longer side, alternately, so as to present a zigzag appearance; bifurcating pieces all larger than the others, and extending out, on the dorsal side of the arms, into pointed prominences, sometimes assuming the character of short spines, which, with the lateral processes of the other pieces, give the arms a very rough, harsh appearance.

Surface of the body plates with deep excavations at the corners, and strong ridges or carinæ between the excavations. Of these carinæ, two descend diverging from the middle of the upper side of the first radials (along which there is also a transverse ridge), to connect with others on the subradial pieces. Sutures between the first and second radial pieces very widely gaping. Column round and very slender near the base, where it is composed of pieces of moderate thickness, every alternate or third one of which projects out distinctly beyond the others. Central canal minute and apparently round.

Hight of body to the top of the first radial pieces, 0.10 inch; breadth, 0.31 inch; length of arms, about 1 inch.

This is another species related to *Zeacrinus spinobrachiatus*, of Dr. White, but it differs in having decidedly more slender arms below the bifurcations, with the arm pieces, particularly above the first bifurcation, arranged much more in zigzag, and their thicker ends more projecting on each side. It is one of the forms combining some of the characters of *Zeacrinus* and *Scaphiocrinus*.

Locality and position—Upper division of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 323 of Mr. WACHSMUTH'S collection.

ZEACRINUS LYRA, M. and W.

Pl. 1, Fig. 11.

Zeacrinus lyra, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 152.

BODY short, obconical, or expanding very rapidly from the column to the top of the first radial pieces, where it is about twice as wide as high. Base not concave but somewhat projecting, and about one-third as high as wide; truncated near three-fourths its breadth by the slightly concave facet for the attachment of the column. Basal pieces presenting a small pentagonal facet above the column, two or three times as wide as long, with lateral margins so short as to appear nearly triangular. Subradial pieces of moderate size, about as wide as long, three hexagonal and two on the anal side heptagonal. First radial pieces generally about twice as large as the subradials, near once and a half as wide as long, and all pentagonal, with the upper side equaling the entire breadth. Second radial pieces of very nearly the same size and form as the first, though the fifth angle and sloping sides are of course above instead of below; each supporting two arms all around. Anal plates nearly all hexagonal, and, as usual, arranged in a double alternating series, the first resting between the superior sloping sides of two of the subradials, under one side of the first radial on the right, and connecting above the middle on the left, with another resting on the superior truncated side of one of the heptagonal subradials, and joining the first radial on the left. Above these the others extend up to connect with the proboscis (so called.)

Arms all distinctly rounded, and after their origin on the second radial pieces each bifurcating first on the fifth, sixth, seventh or eighth piece, above which the outer division bifurcates (or gives off an arm on the inner side) twice or three times at more or less nearly equal distances, all the inner arms continuing simple throughout their entire length, and equaling the outer divisions in thickness. Arm pieces short and very distinctly wedge-formed, each having a moderately stout tentacle at its larger end, along the inner lateral margins of the arms; axillary or bifurcating pieces a little larger than the others, but not more convex. Tentacles composed of joints about twice as long as wide.

Body plates not convex, and merely separated by linear sutures, which are not gaping even between the first and second radials; entire surface more or less granular.

Hight of body to top of first radials, about 0.25 inch; breadth, about 0.50 inch; length of arms, apparently nearly 2 inches.

This species is related to *Poteriocrinus bursæformis*, of White, which has its body formed exactly as in *Poteriocrinus*, with its arms and primary radials presenting all the characters of *Zeacrinus*, as was noticed by Dr. WHITE; thus showing, with the species under consideration and some others, that *Zeacrinus* can scarcely be regarded as more than a subgenus under *Poteriocrinites*. The form that we have here described differs, however, specifically from Dr. WHITE'S species, in having its body proportionally shorter and smaller. Its arms also differ in being very distinctly rounded, instead of flat, while its anterior ray supports two arms directly on the second radial piece, as in all the other rays, instead of having the first bifurcation in that ray on the fourth piece.

The specimens are not in a condition to show much of the ventral prolongation, but one of them shows that it is very nearly as long as the arms, and somewhat expanded and crowned with short spines at the upper extremity.

Locality and position—Upper division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 319 of Mr. WACHSMUTH'S collection.

Genus NIPTEROCRINUS, Wachsmuth.

Proceed. Acad. Nat. Sci., Phila., 1868, p. 341.

(νιπτήρ, a washing vessel; κρίνον, a lily; in allusion to its basin-shaped body.)

Mr. Wachsmuth has proposed the above name, in manuscript, for a type agreeing with *Cyathocrinus* proper in the thinness of its body plates, in the nature of the bifurcations of its arms, and apparently in the general structure of its body, excepting that it has no anal plate, the first radials being large, wide, and in contact all around, so as to leave no spaces for anal or interradial pieces. The succeeding radials after the first are comparatively small, and number from three to four (so far as yet known) to each ray, the first always resting in rounded sinuses in the upper edge of the large first radials, much as in *Cyathocrinus*, excepting that these free radials are very short, more as we see in *Barycrinus*. They differ, however, from those of both *Cyathocrinus* and *Barycrinus*, in each having its lower edge along the outer side of the arms produced downward, into a corresponding sinus in the upper outer edge of each succeeding piece below, so as to present much the appearance seen in the arms of *Taxocrinus*, *Onychocrinus* and *Forbesiocrinus*, excepting that the produced part does not seem to be separate patelliform pieces, but merely the downward produced lower outer edge of each arm-piece itself.

None of the specimens yet found show the *number* of basal pieces, but we can see that its body is composed of small basals, with five well-developed subradials of uniform shape, and five large first radials. This structure of the body, it will be seen, is exactly that of *Erisocrinus*—that is if the base is composed of five pieces, which is very probable. The whole structure and aspect of the parts above, however, is entirely different in these groups, since in *Erisocrinus* there are always but two primary radial pieces to each ray, while the second radials are as large as the first, and instead of merely resting in small sinuses in the upper part of the latter, the two *articulate* together by straight edges across their entire breadth, the articulating edges being always provided with a crenated transverse ridge and furrows. The arms of *Erisocrinus* are also much stouter, and present none of the characters of the type under consideration, while all of its body and arm pieces also differ in being very thick.

It is an interesting fact that the column of the genus here described, as well as its arms, present a striking similarity to that of *Taxocrinus* and allied groups, being round, and composed near the body of exceedingly thin pieces, connecting by crenate surfaces, and provided with a comparatively small central canal. Notwithstanding these points of resemblance, however, to *Taxocrinus*, it is evident that this group is more nearly allied to *Cyathocrinus*. If it has, as seems to be the case, five basal pieces, the formula of the genus would be as follows:

Basal pieces 5, subradials 5, all of the same form; radials 4 to 5 × 5, the first being large and forming the larger part of the body, the others small and free; anals 0; interradials 0; arms bifurcating, and resembling those of *Taxocrinus*.

Some five or six specimens of this type show that the absence of anal pieces is not an abnormal, but a constant character.

NIPTEROCRINUS WACHSMUTHI, M. and W.

Pl. 2, fig. 4.

Nipterocrinus Wachsmuthi, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1868, p. 341.

BODY rather deeply basin-shaped, or a little more than twice as wide as high, rounding under from the top of the first radials to the column. Base small, flat, and nearly hidden by the column. Subradial pieces of moderate size, somewhat wider than long, and all pentagonal, there being no visible angle at the middle of the under side of any of them. First radials comparatively very large, or about three times the size of the subradials, twice as wide as high, and all alike pentagonal, while each is provided with a rather deep, rounded sinus above, equaling about one-third of its breadth, for the reception of the succeeding radials, on each side of which its upper margin is nearly straight, horizontal, and not incurved. Second radials so short as scarcely to fill the sinus in the upper side of the first, and owing to the concave outline above, often presenting a narrow, transversely crescentic form. Third and and fourth radials (where there are five) very short, or several times as wide as long, and usually somewhat arcuate inversely. Last (fourth or fifth) radial a little longer than the next below, and generally trigonal or subpentagonal (the upper angle being somewhat salient), and supporting the arms on its sloping sides. Arms rounded, rather divergent, and bifurcating on the sixth or seventh piece above their bases, and again once or oftener further up, the divisions above each bifurcation being about half as large as the main arm below; arm pieces about twice as wide as long, not wedge-shaped, but all showing the downward curvature quite distinctly, and slightly constricted on each side. Surface merely finely granular, and the plates of the body neither beveled nor tumid. Column composed of such thin pieces that about fifteen of them may be counted in a length equaling its own thickness near the base.

Hight of body of the largest specimen to top of first radials, about 0.43 inch; breadth, near 1 inch; thickness of column of same near base, 0.20 inch; diameter of its sub-pentagonal canal, 0.05 inch.

This Crinoid is so unlike all others known to us, that it is scarcely necessary to compare it with any of the described forms. The specific name is given in honor of Mr. CHARLES WACHSMUTH, the author of the genus, to whom we are indebted for the loan of the typical specimens.

Locality and position—Upper Burlington beds of the Lower Carboniferous. Burlington, Iowa. Mr. WACHSMUTH'S colection.

NIPTEROCRINUS ARBOREUS, Worthen Ms.

Pl. 4, Fig. 8.

BODY cup-shaped, wider than high, rapidly enlarging to the top of the subradials, and more gently from thence to the top of the first radials. Base small and flat, and mostly covered by the columnar joints. Subradials nearly equal in size, width and hight about equal, and all pentagonal. First radials about twice as wide as high, a little more than twice the size of the subradials, and all pentagonal. The sinus for the succeeding radials occupies about one-half of their width, with their upper margins incurved on each side of the sinus. Second and third radials nearly equal in size. Fourth radial sharply trigonal in outline, giving support to an arm on each of its upper angles, which bifurcate again on the fourth plate above, on the only ray preserved in the specimen under examination. Plates of the body all finely granulose under a good lens. Column composed of alternate thick and thin plates near its upper extremity.

Locality and position—Lower division of the Burlington beds of the Lower Carboniferous, at Burlington, Iowa.

GENUS SYNBATHOCRINUS, Phillips, 1836.

SYNBATHOCRINUS WACHSMUTHI, M. and W.

Pl. 2, Fig. 5.

Synbathocrinus Wachsmuthi, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 67.

BODY below the top of the first radial pieces nearly semi-globose, or approaching semi-oval, being about twice as wide as high, and rounding to the column below. Base forming one-third to nearly one-half the hight, somewhat basin-shaped, and obscurely pentagonal in outline as seen from below; basal pieces with the two larger divisions wider than high, and hexagonal in outline, and the smaller about as wide as high, and pentagonal in form. First radial pieces two-thirds to three-fourths as high as wide, with a general quadrangular outline; but two of those on the anal side have each one of the superior lateral angles slightly truncated to form a notch for the reception of the first anal piece, so as to give each an additional angle. Second radial pieces of nearly the same size as the first, but not tapering upward as much as the first do downward, quadrangular in outline, and generally about three-fourths as long as wide. First anal piece about half as wide as long, pentagonal in form, and equaling the length of the second radial pieces; second anal piece nearly half as long as the first, on the truncated upper end of which it rests, trigonal in outline, the upper angle being acute.

Arms very long and very gradually tapering, angular along the middle of the dorsal side, and each composed of more than thirty quadrangular pieces, that are somewhat wider than long, and provided with a very deep ambulacral furrow within. Minute ambulacral pieces extending up the furrows of the arms, from five to seven to each arm-piece in each row, the two rows arching over the deep furrows. Proboscidiform ventral tube very long, slender, cylindrical, and composed of apparently not more than two or three vertical ranges of oblong curved pieces, about half as long as those of the arms.

Column comparatively rather stout, rounded, and composed near the base of more or less irregular pieces, gradually becoming thicker farther down, and all pierced by a small rounded or subpentagonal central canal.

Surface, when well preserved, showing under a strong magnifier minute granulations, with a tendency to run together into a kind of vermicular style of marking.

Hight of body of a medium sized specimen, to the top of the first radial pieces, 0.16 inch; breadth, 0.28 inch; hight to top of second radial pieces, 0.30 inch. Length of arms, about 3 inches; breadth of same at the base, 0.15 inch. Thickness of column, 0.10 inch.

This species will be at once distinguished from all the others known to us, by having its body obtusely rounding under to the column below, instead of expanding upward from the same, with straight or concave sides. By this character alone of its body, exclusive of the second radials, when found detached, it can readily be distinguished from *S. dentatus*, Owen and Shumard, as well as from *S. Wortheni* and *S. papillatus*, Hall.

We have elsewhere noticed the occurrence of a long pipe-stem-like ventral tube in this genus, and a double series of minute ambulacral pieces extending up, and apparently arching over, the ambulacral furrow of each arm.* These characters were first observed in this species, in which the ventral tube seems to be nearly as long as the arms. We have also seen indications of the same characters in *S. Wortheni*, and fragments of other undetermined species, and hence have little doubt that they occur in all the species of the genus, when well preserved. There is perhaps scarcely any other type of all the various genera of

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* Sometimes these pieces are thrown apart along the middle, as if they had been movable and articulated so as to open or close together over the ambulacral furrows. So far as we have been able to see there would appear to be no pinnulæ in this genus.

Crinoids, in which one would less expect to find such an elongated ventral tube, than in this.

Locality and position—Upper division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 335 of Mr. WACHSMUTH'S collection.

SYNBATHOCRINUS BREVIS, M. and W.

Pl. 2, Fig. 6.

Synbathocrinus brevis, MEEK and WORTHEN. Proceed. Acad Nat. Sci., Phila., 1869, p. 68.

BODY small, expanding rather rapidly, with nearly straight sides from the base to the top of the first radial pieces, thence contracting very slightly to the top of the second radials. Form and arrangement of the body pieces very nearly as in the last. Arms comparatively short and tapering rather rapidly at the extremities, angular or subcarinated along the middle of the dorsal side, the carina being interrupted or obsolete near the sutures between the arm pieces, so as to present, as seen in outline, a subcrenate appearance; arm pieces eighteen to each arm, excepting the first one, slightly wider than long. Column slender, round, and composed of alternately thinner and thicker pieces near the base, some of these 0.25 inch farther down, however, being as long as wide, all marked with strong radiating striæ on their articulating surfaces, and pierced by a small, apparently round, central canal. Surface finely granular.

Hight of body to the top of the first radial pieces, 0.15 inch; to top of second do., 0.20 inch; breadth, 0.21 inch; length of arms, 1.35 inches.

This species will be readily distinguished from *S. Wortheni*, *S. dentatus* and *S. papillatus*, by its much shorter arms, which have scarcely two-thirds as many pieces as in those species. Its body is also rather less spreading, and slightly more inclined to round in to the column below, but not near so much so as in the last described species, from which it also differs in having much shorter arms.

Locality and position—Lower Burlington beds, Burlington, Iowa. Lower Carboniferous. No. 336 of Mr. WACHSMUTH'S collection.

GENUS DICHOCRINUS, Munster, 1839.

DICHOCRINUS LINEATUS, M. and W.

Pl. 3, Fig. 1.

Dichocrinus lineatus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 69.

BODY ovoid-subglobose, about as wide as long, not rounded below, but abruptly tapering to the column; widest near the middle, and but slightly contracted above. Base forming very nearly half the hight, and expanding rapidly, so as nearly to equal at the top the greatest breadth of the body; margins faintly sinuous for the reception of the next range of pieces; sutures a little furrowed, but anchylosed. Radial pieces quadrangular, generally nearly or quite as wide as long; sinus above for the reception of the second radials shallow, rounding, and equaling about half the breadth of the upper margin, marked with fine, radiating striæ at the outer margin. Anal piece as wide below as the first radials, but narrower above, and slightly shorter; subpentagonal in form, being but very obtusely angular in the middle below. (Succeeding parts unknown.)

Surface ornamented with numerous sharply elevated lines slightly less than the furrows between. Of these lines, on the base, a part near each lateral margin run parallel to the same, while other series further from the margins, although parallel with each other on each side of the middle, run obliquely so as to connect with the lateral ones and with each other along the middle, in such a manner as to form three divaricating series on each piece; near the upper margins there are also traces of a few very fine, crowded striæ running parallel to the same. On the first radial and anal plates there are also a few fine, transverse striæ near and parallel to the lower margins, while on a triangular central space, with its most acute angle terminating near the middle of the top, there are vertical or slightly converging striæ, of the same size as the divaricating series on the base; and on each upper lateral space, on each side, another series runs up and down, parallel to the lateral margins. Column rather small, round, and provided with a very minute central perforation.

Hight of body to top of first radials, 0.65 inch; breadth, 0.66 inch; hight of base, about 0.30 inch.

This species seems to be somewhat intermediate in its characters between *D. ovatus* and *D. striatus*, of Owen and Shumard. From the first it differs in having distinct, sharply defined, continuous lines on the body plates instead of merely rows of depressed granules, and these lines also run differently on the basal pieces from the rows of granules on that part of *D. ovatus* which are described as forming a series of hexagons, one within the other, instead of forming three series of triangles, as the lines on our species shows a tendency to do. The lines are also as well defined on the radial and anal pieces of our species as on the base, while the surface of these parts of *D. ovatus* is described as being merely "corrugated."

In having continuous, well defined, raised lines, it agrees more nearly with *D. striatus*, of Owen and Shumard, but it is easily distinguished from that species by having these lines very much finer and more crowded, as well as greatly more numerous, there being about ten of them in the space of 0.20 inch, which only includes four or five of those on *D. striatus*.

Locality and position—Lower Burlington beds, Burlington, Iowa. Lower Carboniferous. Mr. WACHSMUTH's collection.

DICHOCRINUS PISUM, M. and W.

Pl. 3, Fig. 2.

Dichocrinus pisum, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 69.

BODY small, somewhat cup-shaped, approaching subglobose, rather depressed or flattened below, and from one-fourth to one-third longer than wide, slightly contracted at the top. Base nearly flat, or presenting a shallow dish-shaped, subcircular outline; facet for attachment of the column very small. First radial plates generally slightly longer than wide, and nearly quadrangular in form, comparatively moderately thick; sinus in the upper margin of each, for the reception of the second radials, very shallow, and about half as wide as the upper margin. Anal plate wider below than any of the first radials, but narrowing upward; provided with a very obscure angle at the middle of the under side, so as to present a subpentagonal outline. (Arms and vault unknown.)

Surface ornamented with comparatively strong, rounded costæ, wider than the furrows between. On the base these are arranged in three divaricating series, the lateral costæ being parallel to the lateral margins, and the divergence upward. On the radial and anal plates there are 7 or 8 of these costæ which run nearly vertically and parallel, the lateral ones, however, converging above, so as to leave small triangular spaces on the superior lateral corners, on which there are a few short costæ not properly connected with the others.

Hight of body, 0.30 inch; breadth, 0.37 inch. Costæ on radial plates, six or seven in the space of 0.20 inch.

In the coarseness of its costæ this species is nearest like *D. striatus*, of Owen and Shumard, but it differs in having its costæ rather smaller, more rounded and separated by furrows, distinctly smaller than the costæ themselves, which are also without the numerous little asperities seen on those of *D. striatus*. It is also a smaller, shorter species, with a much more depressed or nearly flat base.

Locality and position—Upper division of the Burlington group, at Burlington, Iowa. Mr. WACHSMUTH'S collection.

GENUS CALCEOCRINUS, Hall.

Calceocrinus, Hall, 1852. Palæontology, N. Y., Vol. II, p. 352.

?*Cheirocrinus*, Hall, 1860. Thirteenth Report Regents University, N. Y., (State Cab., N. H.) p. 122 (not *Cheirocrinus*, Eichwald, 1856. Bull Soc. des Nat. Mosc. Vol. 29 p. 128, and Leth. Ross., Vol. I, p. 645, Pl. xxxii, Fig. 1, a, b., 1860.)

Dr. SHUMARD has suggested, in his catalogue of North American Palæozoic *Echinodermata* (Trans. Acad. Sci., St. Louis, ii, p. 358, 1866), that the curious genus of Crinoids described by Prof. HALL, in the Report of the Regents, cited above, under the name *Cheirocrinus*, may be the same type for which Prof. HALL had previously proposed the name *Calceocrinus*, in the Second Volume of the Palæontology of N. Y. The name *Calceocrinus* was proposed by him for some subtrigonal pieces of a Crinoid, which, judging from his figures and description, certainly resemble *very closely* the basal piece of the subsequently proposed genus *Cheirocrinus*—so closely indeed, that we are much inclined to adopt Dr. SHUMARD's suggestion that they may belong to the same type. Still it seems very improbable that Prof. HALL, with the original typical specimens of his *Calceocrinus* (of which he says many specimens, all agreeing in form, have been found) at hand for comparison, should have been less liable to understand their true relations to his subsequently described type than others, with only his figures and description of *Calceocrinus* accessible for comparison, and consequently proceeded to re-describe the same genus under another name, that he had previously called *Calceocrinus*.

The synonymy is also unfortunately still farther complicated, by the fact that Prof. HALL happened to select for one of the above mentioned genera, proposed by him, the name *Cheirocrinus*, which had been used by EICHWALD, in 1856, for a genus of Cystidians. EICHWALD's proposed genus seems to be nearly related, as he has stated, to *Echinoencrinites*, though it is very probably distinct. If so, then the name *Cheirocrinus* would have to stand for his type, and could not be retained for that described by Prof. HALL, even if distinct from his *Calceocrinus*. In that case, to avoid confusion, the form here under consideration might be called *Eucheirocrinus*.

Until these questions of synonymy can be cleared up, however, we prefer to describe our species, provisionally, under the name *Calceocrinus;* although, if the type of that genus is distinct from *Cheirocrinus*, and the latter name can stand, they would have to be ranged under it, as they are clearly congeneric with the types for which it was proposed.

It is evident that this remarkable genus differs so widely from all the other known types, that it must be regarded as belonging to an entirely distinct and unnamed family, which might be called *Calceocrinidæ*, as it is almost a certainty that *Calceocrinus*, even if generically distinct from the forms here under consideration, would at least belong to the same family, and if they are generically identical, *Calceocrinus*, being the older name, would have to stand for the typical genus.

CALCEOCRINUS? WACHSMUTHI, M. and W.

Pl. 2, Fig 1.

Calceocrinus Wachsmuthi, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 74.

BODY small, compressed antero-posteriorly; above the base approaching an oblong outline, being longer than wide, a little concave in the middle of the dorsal side, and with the lateral margins of the dorso-lateral pieces constricted in the middle, and rounded and curving inward or forward, so as to form a part of the ventral side. Basal piece subtrigonal, about twice as wide as high, truncated its entire breadth above for connection with the succeeding piece by a widely gaping suture, evidently constructed so as to permit it to be opened out on a line with the body, though in the specimens seen it is always folded close in against the ventral side; facet for the attachment of the column truncating the lower end, concave, and equaling about half the breadth. Column comparatively rather stout, composed near the base of alternately thicker and thinner pieces, becoming more slender, and composed of longer and more uniform pieces farther down; central cavity pentagonal. Body plates closely anchylosed, lower dorsal plate triangular, about one-third as large in the middle as the dorso-lateral pieces, which are between three and four times as long on the outer side as wide. Upper dorsal plate subtrigonal, with the lateral angles a little truncated obliquely outward, about twice as wide as high, and truncated about three-fourths its breadth above, for the reception of the middle or dorsal arm, more than filling the broad triangular notch between the upper ends of the dorso-lateral pieces.

Dorsal arm simple, and composed, above the first piece, of oblong pieces that are rounded on the outer side, and about one-third longer than wide. Lateral divisions of the rays supported on the superior latter sloping side of each dorso-lateral piece, composed each of (as far as can be seen) five pieces in a direct range, extending out laterally, and curving around toward the ventral side; of these pieces the first is very short, and does not support an arm, while each of the other bears an erect arm above. Each of these lateral arms, as far as can be seen, gives off a small division on the dorsal side of the third piece above the base, while the main division of each bifurcation again on the fourth piece above, the bifurcating pieces being a little tumid. All the arms have a deep ambulacral furrow within.

Pieces of the ventral side unknown.

Length of base, 0.10 inch; length of body, exclusive of base, 0.35 inch; breadth do., 0.27 inch; length of arms, 1 inch.

This species is related to *C. dactylus*, Hall, but differs in having its dorsal arm simple, instead of bifurcating, and its lateral arms bifurcating first on the third instead of the fourth piece. From *C. ventricosus*, Hall, it also differs in having the dorsal arm simple, instead of bifurcating, while its upper dorsal piece is distinctly shorter in proportion to breadth than in that species.

If farther comparisons should show these forms to be generically distinct from *Calceocrinus*, and *Cheirocrinus* is found to be tenable, this would have to be called *Cheirocrinus Wachsmuthi*.

The specific name is given in honor of Mr. CHARLES WACHSMUTH, of Burlington, Iowa, to whom we are indebted for the use of the specimens from which the description was made out.

Locality and position—Upper Burlington beds of Lower Carboniferous, at Burlington, Iowa. Mr. WACHSMUTH's collection.

GENUS ERISOCRINUS, M. and W., 1865.

Geol. Surv. of Illinois, Vol. II. p. 315.

This genus was originally proposed by us for the reception of two very similar forms, one of which, from the upper part of the Coal Measures of Illinois, we called *E. typus*, and the other, from the same horizon in Nebraska, we called *E. Nebrascensis*. The specimens then known consisted only of the body up to the summit of the first radials. This part of these forms is subhemispherical in outline, being rounded below, and evenly truncated above, with five minute or very small basal pieces, surrounded by and alternating with somewhat larger subradials, which in their turn alternate with and support five larger, thick first radials, with articulating facets occupying their entire breadth above, for the reception of the next range of radials. These radials being in contact with each other all around, leave no spaces for anal or interradial pieces. All the specimens then known had lost the arms, but those of other species now before us are seen to be simple from their origin on the second radial pieces, and each composed of a single series of transversely oblong pieces.

Subsequently another species was found in the same beds in Illinois, presenting an obconic form of body, with a protuberant base, and we were so much impressed with its resemblance to an East Indian Carboniferous type described by Dr. DE KONINCK, under the name *Philocrinus*, in 1863, that we were led to think our genus not distinct, and his name having priority of date, we referred the two forms we had first described to it.* In doing this, however, we thought it desirable to change the specific name of our species *typus*, it not being the type of the genus *Philocrinus*.

We were led to regard our species as not being generically distinct from *Philocrinus*, because they agree exactly in all their known generic characters, unless the lower range of pieces shown in the figure of *Philocrinus* really are the basal pieces, which would make that genus without subradial pieces. As the typical specimen, however, seems from the figure to be a little defective at the lower extremity, and the lowest range of pieces represented, if really prolonged to the bottom of the body, would have to present a very remarkably elongate cuneiform outline, we were strongly impressed with the probability of there being another smaller series of true basal pieces below the lowest range represented (but not visible in consequence of the condition of the specimen), especially as these forms appear to agree so nearly in other respects. If so, there would be no generic differences between *Philocrinus* and *Erisocrinus*, and the American species would have to stand under the former name. If *Philocrinus*, however, really has no subradial pieces, then of course *Erisocrinus* must be an entirely distinct genus. Until all doubts on this point, however, can be removed, we finally concluded to retain our name *Erisocrinus*.

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* Our later comparisons of the other specimens have led to the conclusion that these are only varieties of one species. Good specimens of a form described by us in the Proceedings for August, 1865, from a number of detached plates under the name *E. tuberculatus*, also shows that it does not belong to this genus, as it has a large, oblong subanal and a true anal piece resting on the upper truncated edge of one of the subradials. Hence, although it agrees exactly in all its other known parts with *Erisocrinus*, it cannot properly be retained in that genus, but would belong to *Cyathocrinus*, giving that group the limits generally admitted. It is not a typical *Cyathocrinus*, however, but nearer the group *Barycrinus* and yet differs from the typical forms of that group in having its second radials as wide as the first, and articulating by broad transversely furrowed facets, instead of merely resting in comparatively small sinuses in the upper edge of the latter.

The close similarity of the body of some species of this genus and that of another allied form, found in the upper members of the Coal Measures of Nebraska, to the corresponding parts of the genus *Encrinus*, and their wide difference from all the then known Lower Carboniferous Crinoids of America, have been appealed to as facts, sustaining an opinion maintained by some, that these Nebraska beds belong to the age of the Permian of Europe, instead of the Coal Measures. The fact, however, that we now have the species of this genus described in this paper, from the lower part of the *Lower* Carboniferous or Mountain Limestone at Burlington, ought, we should think, to be sufficient evidence that no such conclusions can be properly based on this type of fossils.

ERISOCRINUS ANTIQUUS, M. and W.

Pl. 2, Fig. 3.

Erisocrinus antiquus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 71.

BODY small, much depressed, somewhat basin-shaped, or very rapidly expanding from the base to the summit of the first radial pieces, at the connections of which it is very faintly sinuous around the margins as seen from below. Base small, subpentagonal, almost entirely covered by the round, flat facet for the attachment of the column; basal pieces exposing very small pentagonal surfaces three or four times as wide as long. Subradial pieces each about one-half to two-thirds as large as the whole base, all uniformly pentagonal (there being no visible angle at the middle of the base), and with the upper sloping sides each about twice the length of the lateral margins. First radial pieces about twice as large as the subradials, half as long as wide, and all equally pentagonal, with the lateral and inferior sloping edges of nearly equal length, and the straight, upper truncated side equaling the entire breadth; articulating upper edge very thick, deeply notched at the middle on the inner edge, and provided with the usual transverse ridge and furrows. Second radials as wide as the first, and about three-fourths as long as wide, angular in the middle on the dorsal side, and constricted on each lateral margin;

pentagonal in form, and supporting on their superior sloping sides the first arm pieces, which are quadrangular, slightly constricted on each side, and a little wider than long; arms beyond these simple (as far as they can be traced in the specimen), two to each ray, or ten in the whole series, and composed of somewhat shorter, quadrangular pieces, provided with a well defined ambulacral furrow within. Surface merely finely granular.

Hight of body to the top of the first radials, 0.12 inch; breadth, 0.23 inch.

This little species will be readily distinguished from those already known from the Coal Measures by its much more depressed, rapidly expanding body, as well as by its proportionally longer and constricted second radial pieces.

Locality and position—Lower division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. Mr. WACHSMUTH'S collecection.

ERISOCRINUS WHITEI, M. and W.

Pl. 2, Fig. 2.

Erisocrinus Whitei, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 72.

BODY of moderate size, very much depressed, or almost dish-shaped below the top of the first radials, being about three times as wide as high. Base very small, and entirely hidden by the slender, round column, when it is attached. Subradials forming together a nearly flat, pentagonal disc. First radials comparatively large, thick, and presenting a general quadrangular outline, there being scarcely any visible angle at the middle of the under side, which is distinctly shorter than the straight, transverse upper edge, and about as long as the diverging lateral margins. Second radial pieces as large as the first, which they equal in breadth, broadly rounded on the outer or dorsal side, pentagonal in form, and each supporting on its superior sloping sides two arms, thus making ten to the whole series. Arms simple from their origin, flat on the outside, and composed of quadrangular pieces, the first of which is nearly as long as wide, and the others about half as long as wide, with scarcely any tendency to assume a wedge shape. Surface merely finely granular.

Hight of body to the top of first radial pieces, measuring to their inner edges, 0.14 inch; breadth, 0.40 inch; breadth of column, 0.08 inch.

This species will be distinguished from the last by its more depressed body, which has its under side between the top of the first radial pieces and the column, slightly convex in outline instead of concave, which results from the greater prominence of the basal and subradial pieces of the latter. The species under consideration likewise has its radial pieces proportionally wider—particularly the second radials, which also differ in being broadly rounded, instead of angular, on the dorsal side, and not constricted on their lateral margins. Its arm pieces are also flat, instead of convex, on their outer side.

Owing to the fact that the column entirely hides the very small base of this species, and the sutures between the subradials, or first range of pieces around the summit of the column, are rather obscure, and really look as if there were only three, instead of five of these pieces, we were led to suspect that these might be the basal pieces, which would remove the species entirely from the genus *Erisocrinus*. On removing the column, however, we have been able to see what we believe to be five minute basal pieces within the first series surrounding the end of the column, which would necessarily have to be succeeded by five pieces in the next range. Hence, we think we can scarcely be mistaken in supposing the appearance of only three suture lines between the plates, we regard as the subradials, as merely an abnormal condition, resulting from two of the suture lines being anchylosed, or accidentally obliterated. This supposition is also strengthened by the near specific relations between this and the last described species, in which all the basal, subradial and other plates are clearly and distinctly seen.

In case our genus *Erisocrinus* is not distinct from *Philocrinus*, with which we have already suggested it may be identical, then the names of the species here described will have to be written *Philocrinus antiquus* and *P. Whitei*.

The specific name of this species is given in honor of Dr. C. A. WHITE, the able State Geologist of Iowa.

Locality and position—Upper division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. Mr. WACHSMUTH'S collection.

GENUS PLATYCRINITES, Miller.

PLATYCRINITES TENUIBRACHIATUS, M. and W.

Pl. 3, Fig. 4.

Platycrinites tenuibrachiatus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869 p. 165

BODY rather small, subglobose, being somewhat wider than high. Base shallow, or dish-shaped, with a subpentagonal outline, and a rather broad shallow concavity below, nearly twice as wide as the rather small round facet for the attachment of the column. First radial pieces a little wider than high, having a general quadrangular form, but with the superior lateral angles slightly truncated for the reception of the interradial pieces, and the lower sides a little convex in outline; sinus in the upper side of each equaling about half its breadth, and extending down on the outer side about one-third to one-fourth its length. Sutures channeled by the beveling of the edges of the plates. Second radial pieces very small, wider than long, triagonal in form, and wedging out on each side so as to allow the first brachial pieces to come in contact with the first radials at the lateral edges of the sinuses in the same.

First divisions of the rays, from their origin on the second radial pieces, each round and composed of a single series of somewhat wedge-shaped pieces to the fourth piece, which has a pentagonal outline, and gives origin to two divisions, the inner one of which is smaller than the other and without farther bifurcations, being a simple arm, composed below, for some little distance, of a single series of wedge-formed pieces, beyond which it passes gradually into a double series of alternating pieces, while the outer division bifurcates on the second piece, its outer subdivision remaining simple like the inner of the first divisions, already described, and its inner division bifurcates again on the fourth pieces, forming two arms like the others, thus making four arms to each of the two main divisions of each ray, or forty arms to the entire series, all of which are long, slender, and without spines or other asperities. Pinnulæ, or so-called tentacles, slender, rather crowded, and composed of joints that are longer than wide, and deeply furrowed within.

Surface of body plates marked with small rough ridges, which on the first radial pieces run parallel to the lower and lateral margins, with more or less irregularly disposed granules on the central region, sometimes showing a tendency to radiate from the sinuses for the second radial pieces.

Hight of body, 0.30 inch; breadth of same, 0.50 inch; length of arms, measuring from the first divisions on the second primary radials, about 1.50 inches; do., to first bifurcations above, 0.22 inch; breadth of each individual arm above all the bifurcations, 0.05 inch.

This species is related to *Platycrinus Americanus*, of Owen and Shumard, with which it agrees in the size and form of its body. Its surface sculpturing, however, is somewhat different, that species having merely a nodular ridge running along the lower and lateral margins of the first radial plates, and two others starting from the lower lateral angles and converging to the sinuses in the middle of the upper edge, with little isolated nodes on the intermediate spaces; while in the species under consideration there are merely three somewhat nodular ridges, parallel to the basal and lateral margins of these plates, with more or less granules in the central region. As such markings, however, are subject to some variation in individuals of the same species of this group, we should not have regarded the differences mentioned of sufficient importance to warrant the establishment of another species, if it were not for the additional fact that Mr. WACHSMUTH finds specimens agreeing exactly with OWEN and SHUMARD'S species in the ornamentation of the body, and yet having only six arms to each ray, or thirty in the entire series, instead of eight to each ray, as in that under consideration.

P. Wortheni, Hall, agrees with this in having eight arms to the ray, but they are much stouter, and differ in being roughened by numerous small asperities, while its second radial pieces are much smaller, and each supports on each side above only two very short pieces between it and the first bifurcations above, instead of four. Similar differences are also seen in the details of the other divisions, while the surface ornamentation of the two species is entirely different, and the base of the

Wortheni is flat or broadly concave, instead of being moderately convex with merely a central concavity.

Locality and position—Upper beds of Burlington Limestone, Burlington, Iowa. No. 218 of Mr. WACHSMUTH'S collection.

PLATYCRINITES PLANUS, O. and S.

Pl. 3, Fig. 5.

Platycrinus planus, OWEN and SHUMARD, 1852. Jour. Acad. Nat. Sci., Phila., new series, Vol. 2 p. 57. Geol. Iowa, Wis. and Minn., p. 587, Pl. 5 A, Fig. 4.

(Burlington Limestone, Mr. WACHSMUTH'S collection.)

PLATYCRINITES SUBSPINOSUS, Hall.

Pl. 11, Fig. 2.

Platycrinus subspinosus, HALL, 1858. Geol. Iowa, Vol. I, Part II, p. 536. Pl. 8 Fig. 9 and 10.

(Burlington Limestone, Burlington, Iowa.)

PLATYCRINITES BURLINGTONENSIS, O. and S.

Pl. 3, Fig. 6.

Platycrinus Burlingtonensis, 1850. OWEN and SHUMARD. Jour. Acad. Nat. Sci., Phila., 2d Ser., Vol. II, p. 60, pl. 7, fig. 5 Geol. Iowa, Wiscon. and Minn., (1852) p. 589, tab. 5 A, fig. 5; Shumard. Cat. Pal. Foss. N. Am., part 1, Ech., (1865) p. 387; McChesney Trans. Chicago Acad. Sci., (1867) Vol. I, p 4, pl. iv, fig. 3.

Platycrinus inornatus, MCCHESNEY, 1860. New Pal. Foss., p. 6; Illustrations same, (1865) pl. 4, fig. 3.

BODY under medium size, cup-shaped, gradually expanding upward, not quite twice as wide as high, and composed of moderately thick plates, with sutures (excepting those between the basal plates) rather distinctly furrowed. Base saucer-shaped, or between three and four times as wide as high, rounding abruptly under, and moderately concave in the middle below; facet for the attachment of the column slightly impressed and very nearly circular. First radial plates a little wider than high, and but slightly broader above than below, having a general quadrangular outline, with the superior lateral angles truncated and incurved, and the lower margins nearly straight or slightly convex in outline; sinus for the reception of the second radials about half as wide as the upper part of the first, and not deeply excavated. Second radials small, but generally quite filling, or sometimes a little more than filling the sinuses in which they rest, subtrigonal or pentagonal in form, with very short, lateral margins, directed upward and a little outward.

Divisions of the rays, after the first bifurcation on the second radial pieces, each composed first of two pieces in direct succession, the second of which is an axillary piece, and bears an arm on its outer sloping side, while on its inner it supports two pieces in direct succession, the second of which is an axillary piece, and gives origin to two arms, thus making three arms to each of the two main divisions of each ray, or thirty to the whole series.

Arms rather slender, rounded on the dorsal side, and scarcely thicker in the middle than below; each composed near their bases of five or six wedge-formed pieces extending entirely across, but a little above they soon pass into a double alternating series of pieces nearly as long as wide; pinnulæ nearly or quite in contact with each other and composed of pieces three or four times as long as thick. Interradial pieces of moderate size, strongly incurved, and wider below than above; anal piece larger than the interradials, wider than long, hexagonal in form, and not incurved. Vault depressed, convex, or but little elevated, composed of few tuberculiform pieces, about five of the central ones of which are larger than the others, and occupy nearly the whole area. Opening lateral, and either raised into a small protuberance, or more probably extended so as to become proboscidiform. Surface merely finely granular.

Hight of body to top of first radial pieces, 0.38 inch; breadth at same point, 0.66 inch.

This species is more nearly allied to *P incomptus*, of White, than to any of the other smooth species known from the Burlington rocks. In form and the general appearance of the body, these two species are so very similar, that it would probably in some cases be very difficult to distinguish them without seeing the other parts. Dr. WHITE'S species, however, attains a considerably larger size, and has its second radial pieces and those immediately succeeding them turned outward more nearly at right angles to the body. Its vault is also composed of more numerous pieces, and not, as appears to be the case with this, provided with a ventral tube. When its arms are preserved, they are also found to be more numerous, owing to the more frequent bifurcation of the divisions of its rays, so that it has eight arms to each ray, or forty to the whole series, instead of only thirty. The general form of its body, its depressed base, small size, etc., will readily distinguish it from all the other inornate species known from the Burlington rocks.

Locality and position—Lower bed of Burlington group, at Burlington, Iowa. Lower Carboniferous. The specimen represented by fig. 6 belongs to Mr. WACHSMUTH, and is numbered 196 in his collection. It is the first example of this species showing the arms that has been figured, the other published figures merely representing the body.

PLATYCRINITES HALLI, Shumard ?

Pl. 3, Fig. 3.

Platycrinus olla, HALL. Descr. New Crinoidea, Prelim. Notice, p. 16, 1861—(not de Koninck and Le Hon, 1854.)

Platycrinus Halli, SHUMARD. Cat. Pal. Foss., Pt. I, Echinod.—Trans. Acad. Sci., St. Louis, Vol. II, p. 388, 1866.

BODY attaining a rather large size, and composed of thick plates; somewhat urn-shaped, or, when the arm-bases are removed, approaching obovate, the widest part being above the middle. Base more than twice as wide as high and regularly rounded below; sutures sometimes faintly visible. First radial plates large, a little longer than wide, slightly convex, and nearly oblong in general outline, the lower margin being a little rounded, and narrower than the greatest breadth above; sinus for the reception of the second radials equaling about one-half the greatest breadth, and excavated down nearly one-third the length. Second radial pieces very small, or not near filling the sinuses in which they rest, and only showing a minute triangular surface, when the succeeding pieces are attached; succeeding pieces small, short, and directed horizontally outward, the first two resting partly on each sloping side of each small second radial, and partly on the first radial beneath, and each supporting two slightly larger pieces, the last of which is an axillary piece, and bears an arm on its outer sloping side, while the inner bears two pieces in direct succession, the second of which is axillary and bears two arms, thus making six arms to each of the rays; interradials of moderate size, hexagonal in form, longer than wide, and wider below than above.

Vault moderately and regularly convex, and composed of unequal tumid pieces, four or five of which in the central region are much larger than the others; opening decidedly lateral, and directed horizontally outward, occupying a protuberance composed of small pieces, and placed nearly on the same horizon as the arm-bases. Sutures between the body plates more or less distinctly furrowed. Surface smooth or only granular.* Column rather stout, and showing the compressed and twisted character of the genus very distinctly, composed of pieces of nearly uniform thickness.

Hight of body to top of vault, 1.52 inches; breadth, 1.20 inches.

We have referred this specimen to *P. Halli*, of Shumard, with some doubt, because in some of its characters it seems to be quite as nearly allied to *P. incomptus*, of White. It differs, however, from authentic specimens of Dr. WHITE'S species now before us, in the much less depressed form of its body and base, its proportionally longer first radial pieces, and decidedly smaller second radials, in all of which characters it seems to agree more nearly with the description of *P. Halli* (= *P. olla*, of Hall.) The specimen we have figured has lost its arms, as seems to have been the case with the one from which Prof. HALL'S description was drawn up; enough of the free parts of the rays remain, however, to show that there were almost certainly three arms to each main division of each ray, or thirty to the whole series.

Other specimens in Mr. WACHSMUTH'S collection, believed to belong to this species, show three arms to each division of each ray, and in these the arms are rather long, and not sensibly thicker in the middle than at the base, while they show the peculiarity of having along each side a very small pinched projection on each arm piece; the longer diameter of these little projections being ranged transversely outward and inward.

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* The specimen figured shows on the base, and some parts of some of the first radial pieces, indications of a few rather irregularly scattered nodes; but as these are clearly produced by some little boring parasite, (being each with a little pit in its top,) we have not represented them in the figure.

This form has sometimes been confounded with *P. planus*, of Owen and Shumard, but it differs in having much thicker body plates, those of that species being very thin and fragile. The sinuses in its first radial pieces for the reception of the second are also deeper in this than in *P. planus*, while the first radials of that species have their upper lateral margins straight out to the suture, and not truncated as in this, to form a notch for the reception of the subradial and anal pieces. So far as we have been able to ascertain *P. planus* seems also to differ in having the opening of its vault in a much more prominent, if not proboscidiform projection. Its second radial pieces and the others between these and the bifurcations of the rays also differ from those of the form under consideration in not being directed out horizontally.

From *P. æqualis*, Hall, this species differs in having a regularly rounded, or subhemispherical base, and less convex first radial pieces; while its arms, as indicated by specimens apparently belonging to the same species as the figured specimen, are entirely different from those of *P. æqualis*.

The specimen figured by Prof. HALL, on plate 8, of his Iowa Report, under the name *P. planus ?*, is certainly not that species, but has the thick plates, and other characters of the form under consideration, excepting that it has obscure undulations on its basal and first radial pieces, not seen on *P. Halli*, and hence may be new.

Locality and position—Upper part of the Burlington division of the Lower Carboniferous series, at Burlington, Iowa. The specimen figured belongs to Mr. WACHSMUTH's collection.

PLATYCRINITES ÆQUALIS, Hall.

Pl. 3, Fig. 8.

Platycrinus æqualis, HALL, 1861 Desc. New sp. Crin., Prelim. Note, p. 17

BODY rather deeply cup-shaped, rounding below to near the facet for the attachment of the column, which is elliptic and somewhat protuberant, so as to give the sides of the base just above, a slight concavity of outline. Base somewhat basin-shaped, rather more than twice as high as wide, and forming more than one-third of the hight of the body to the top of the first radial pieces; sutures anchylosed, but broadly and rather deeply excavated; basal plates convex or slightly tumid over most of their surface, and curving upward above the middle, to the somewhat constricted suture separating them from the radials above. First radial pieces a little longer than wide, usually somewhat wider above than below, and having a general oblong outline, though the superior lateral angles are obliquely truncated to form notches for the reception of the interradials, and the lower margins are slightly rounded in outline; all convex or rounded over from side to side, on the outer surface, so as to give, with the deeply excavated sutures between, an obtusely lobed appearance to the body, as seen from below; facet for the reception of the second radial pieces equaling about half the breadth of the upper part of the plates, and excavated less than one-third their length downward, at the middle on the outer side. Second radial pieces very small, or only showing a small triangular outer surface, and allowing the first of the succeeding pieces to rest with near one-half of their under surface directly down on the first radials.

Rays, after the first division on the second radials, dividing on the second pieces, the outer division giving origin to an arm, and the inner division bifurcating again on the second pieces, so as to form two arms, thus making six arms to each ray, or thirty to the whole series. Arms long, slender, and directed upward from their bases, the lower pieces and second radials not being much curved outward; all slender below, and increasing slightly in thickness to near the middle, thence tapering very gradually to their extremities; dorsal or outer surfaces of each somewhat rounded, and lateral surfaces flattened, or sometimes even slightly furrowed. Arm pieces, as usual, consisting of a single wedge-formed series near the base of the arms, but gradually passing into a double interlocking series of pieces, which, farther up, near the middle, are very short, and each presenting a curious upward flexure or geniculation in the middle, so as to give a zigzag appearance to the transverse sutures between them. Often at this point of flexure, one of the pieces, on each side of the mesial longitudinal zigzag suture, is divided into two, so as to show a tendency to break up into four alternating rows of very small interlocking pieces to each arm. Pinnulæ in close contact, and composed of joints from three to four times as long as wide on their outer surface.

Vault unknown.* Surface nearly smooth or only finely granular.

Hight of body to top of first radial pieces, 0.84 inch; greatest breadth immediately below the sinuses for the second radials, 1 inch; length of arms from the first division of the rays to their extremities, 3.30 inches; breadth of same near the middle, 0.12 inch.

The body of this species can be distinguished from that of any of the other smooth species of this genus yet known, from the Burlington beds, by the protuberant character of the facet for the attachment of its column, and its slightly tumid basal pieces. Its most marked character, however, is the peculiar geniculation, and duplication of its arm pieces, on each side of the mesial line. This character is so marked that even a fragment of one of its arms, from near the middle, could be readily distinguished from a corresponding part of any of the other species known to us.

We have figured the beautiful specimen represented on plate 3, because it shows the arms and body complete; while the specimen originally described by Prof. HALL consisted merely of a detached base.

Locality and position—Upper bed of the Burlington group, of the Lower Carboniferous, at Burlington, Iowa. The specimen figured is numbered 213, in Mr. WACHSMUTH's collection.

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*Mr. WACHSMUTH thinks this species has a simple lateral opening in the vault.

PLATYCRINITES INCOMPTUS, White.

Pl. 3, Fig. 7.

Platycrinus incomptus, WHITE, 1863. Jour. Bost. Soc. Nat. Hist., Vol. VII, p. 503.

BODY attaining a moderately large size, composed of thick, smooth plates; cup-shaped, with gradually expanding sides. Base depressed or basin-shaped, with under side somewhat impressed in the region of the facet for the attachment of the column; margins curved up to connect with the body plates above. First radial plates wider than high, wider above than below, with superior lateral angles so largely truncated, to form notches for the interradial and anal pieces, as to present almost an irregular hexagonal form, separated from each other and from the base by more or less channeled sutures; sinuses for the reception of the second radials about half as wide as the upper part of the first, and generally not very deeply excavated. Second radials generally filling, and sometimes more than filling the sinus in which they rest, and always more than twice as wide as high; all curving outward nearly at right angles to the vertical axis of the body. Rays, after dividing on the second radials, directed at first nearly horizontally outward, each division consisting of two pieces in direct succession, the second one being axillary, and supporting an arm on its outer sloping side, while on its inner sloping side it bears in direct succession two pieces, the second of which is axillary, and gives origin to two arms or divisions, one of which bifurcates again on the second piece, thus making, as far as the specimen shows, seven or eight arms to each ray. Interradial and anal pieces comparatively large. Surface smooth or only finely granular.

We have not seen a specimen of this species with the vault exposed, but Dr. WHITE describes it as being rather high, and composed of tumid pieces, the largest of which occupy the central region. The opening, he says, is situated about half way between the middle of the vault and the anal side.

The specimen from which our description is drawn up only shows the body, the bases of the arms, and the pieces connecting the latter to the second radials. These pieces, forming the two main divisions of each ray, are in close contact out to where the second bifurcation takes place, where the two main divisions diverge and separate. The arm-bases in this specimen are quite slender.

Another larger specimen in Mr. WACHSMUTH's collection (No. 215 *b*,) has the arms preserved. He thinks this not distinct from Dr. WHITE's species, just described, though its first radial pieces are longer in proportion to breadth, and its arms apparently stouter; still it may be a variety of the the same. It shows clearly four arms to each main division of the rays, or forty to the whole series. Its arms are rounded, and increase gradually in thickness from the base to a distance of about 1.80 inches, and then gradually taper for about 0.60 inch, at which point they are broken off in the specimen, or in part curved in, so that their entire length cannot be seen.

Hight of a small specimen, 0.50 inch to top of first radial pieces; breadth of do., about 0.41 inch. Other distorted individuals seem to have attained twice the diameter of that from which the above measurements were taken.

The specimen from which our description was drawn up and our figure prepared is one of those Dr. WHITE had before him in describing this species, and the characters given by him were in part taken from it. For this reason we have preferred to figure this particular specimen, instead of another in a better state of preservation, because the latter (No. 215 *b*, mentioned above,) may possibly be distinct.

As already mentioned in the remarks in regard to the relations of that species, it seems to be most nearly related to *P. Burlingtonensis*, but differs materially in size, the number of its arms, and other characters already mentioned. In size, and some other characters, it is more nearly allied to *P. Halli*, Shumard, *P. olla*, Hall (not de Koninck), but if that species has been properly identified by all of the Burlington geologists, this one has a more depressed body, larger second radial pieces, a more shallow base, and more numerous arms, which also seem to differ in having very small, pinched nodes along their sides.

Locality and position—Upper part of Burlington division of Lower Carboniferous, at Burlington, Iowa. The specimen figured is numbered 215, *a*, in Mr. WACHSMUTH's collection.

GENUS PENTREMITES, Say.

PENTREMITES BURLINGTONENSIS, M. and W.

Pl. 8, Fig. 7.

Pentremites Burlingtonensis, MEEK and WORTHEN, 1869. Proceed. Acad Nat. Sci., Phila.

BODY attaining a medium size, ovoid, or ovoid-subglobose, depressed and short below, and rounded and more produced above. Supplementary base very small, or only one-fourth as wide as the base, rounded and firmly anchylosed to the true base; short, or apparently composed of not more than three anchylosed pieces. Base of moderate size, much depressed, or having the form of a pentagonal dish. Radial pieces once and a-half as long as wide, rather narrow below and widening upward to near the middle, above which they are very slightly contracted to the top, each divided three-fourths of its length, by its rather wide pseudo-ambulacral sinus. Anal and interradial pieces very small, exposed part presenting an elongate-rhombic outline, the upper part being more elongate and acute than the lower. So-called pseudo-ambulacral areas, wide, moderately convex, tapering rather gradually below the middle, and more abruptly above. Pore or arm-pieces, about 35 on each side of each area, less than half as long transversely as the breadth of the exposed part of the lancet pieces at their widest part, nearly transverse above, but becoming somewhat oblique toward the lower part of the area; supplementary pore pieces small. Lancet pieces exposing a lanceolate form, being widest above the middle, gradually tapering below, and contracting abruptly above; each with its mesial or ambulacral furrow rather wide and deep, and minutely crenate within; transverse furrows well defined, and also minutely crenate. Central hiatus small. So-called ovarian openings small, and those distinct from the anal opening appearing at the surface as four pairs of elongate-oval pores. Anal opening comparatively large, and, as usual in the genus, including one of the pores on each side. Surface ornamented with fine parallel striæ, running as usual in allied species.

Hight of one of the smaller, less globose specimens, exclusive of the little supplementary base, 0.50 inch; breadth, 0.49 inch. Hight of a large more ventricose individual, 0.87 inch; breadth of same, 0.84 inch.

This species has much the form and proportions of the common *P. godoni*, so much so, indeed, that those who give wide limits to species would probably fail to observe the differences. On comparison, however, it will be found to differ in the following characters, viz: in the first place, its pseudo-ambulacral areas are more convex, and not bounded by near such sharply elevated margins of the radials. Its pore pieces are also larger, and scarcely more than half as numerous as in *P. godoni*. Its anal and interradial pieces are likewise decidedly smaller than in that species, while it also presents the well marked difference of having its so-called ovarian openings with each pair appearing at the surface as two closely approximated, but distinct oval pores, instead of as a single rounded, larger opening. It moreover holds a much lower geological position than *P. godoni*.

This is the first true typical *Pentremite* we have seen with each pair of ovarian pores (so called) appearing at the surface as two distinct pores. It must be rather rare, as we have only seen three specimens of it.

Locality and position—Upper division of the Burlington group of the Lower Carboniferous, at Burlington, Iowa. No. 387 of Mr. WACHSMUTH'S collection.

GENUS CODONITES, M. and W.

Pentremites (sp.), of OWEN and SHUMARD, and others; (not of Say).
Codaster (sp.), of SHUMARD;* (not of McCoy).
Codonites, MEEK and WORTHEN, 1869. Proceed. Acad. Nat. Sci., Phila.

This genus agrees with *Pentremites*, excepting in the following important characters: in the first place, its opening corresponding to that usually considered the vent, in *Pentremites*, is proportionally larger, more remote from the center of radiation, and entirely distinct or isolated from the aperture on each side of it, corresponding to a part of those generally called ovarian pores, in the *Pentremites* (Hydrospires of Mr. Billings). These latter openings in the type under consideration also differ from those of *Pentremites* in appearing at the surface as ten separate, elongated slits, situated one on each side of the so-called pseudo-ambulacral areas†, instead of forming, with the anal opening, five round apertures. The typical species (*Pentremites stelliformis*, Owen and Shumard,) also shows twelve of the elongated folds or compressed tubes of thin calcareous matter under each of the pseudo-ambulacral areas, instead of about eight, as in all the true *Pentremites*, so far as we have examined. This, however, may not be a generic difference, taken alone. We likewise believe the typical species to be entirely destitute of any of the pores seen penetrating the pseudo-ambulacra in the true *Pentremites*, which, according to Mr. BILLING'S observations, is the case with *Codaster*.

Compared with *Codaster*, our genus is found to differ in having only two of the slits mentioned in each interradial area, instead of from about eight to sixteen, and in having these openings equally developed in the anal as well as the interradial areas. Its internal calcareous compressed tubes are also placed under the so-called pseudo-ambulacral areas, as in the *Pentremites*, instead of occupying the whole interradial areas, as in *Codaster*. It therefore seems to be an intermediate type between *Codaster* and *Pentremites*, but more nearly allied to the latter than to the former.

As in *Pentremites*, the typical species shows, in adult examples, three firmly anchylosed pieces, forming, together, a protuberance under the basal pieces, and almost appearing as parts of the latter.* These do not alternate with the basal pieces, but have the sutures between them exactly coinciding with those of the base. These pieces might, for convenience, be called supplementary basal pieces, and will, in their different modifications, often furnish good specific characters in this genus, as well as in *Pentremites*, and hence ought to receive especial attention in specific descriptions.

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* It is due to our lamented friend, Dr. SHUMARD, that we should explain here, that in placing the type of this genus provisionally under *Codaster*, he remarked that it differs in several important characters from that group, as well as from *Pentremites*, and that he thought it probably belongs to a distinct group from them both.

† We regard the so-called pore pieces in the Blastoids as merely recumbent arm pieces similar to those of many *Cystoidea*, hence we think it would be more proper to call the pseudo-ambulacral areas, brachial furrows, though for the present we use the term pseudo ambulacral areas, in the sense now in general use.

CODONITES STELLIFORMIS, M. and W.

Pl. 9, fig. 5.

Pentremites stelliformis, OWEN and SHUMARD, 1850. Jour. Acad. Nat. Sci., Phila., Vol. II, p. 67. pl. 7, fig. 16; also (1852) in OWEN'S Geol. Report, Iowa, Wiscon. and Minn., p. 593, tab. V *a*, fig. 10.

Codaster stelliformis, SHUMARD, 1865. Cat. Pal. Foss., Part I, Echinoid. p. 359.

BODY pentagonal-obpyriform, being very narrow below, and rapidly expanding upward from the base to the outer (lower) extremities of the so-called pseudo-ambulacral areas, and depressed convex above, where it presents a distinctly pentagonal outline, owing to the deep interradial and anal sinuses. Supplementary basal pieces forming a short, rounded, stem-like projection, apparently distinctly thicker

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Mr. S. S. LYON was the first author, so far as we are aware, who called attention to these pieces in *Pentremites*, and showed that they are really separable from the basal pieces, in some cases, (See Owen's Kentucky Geol. Report, Vol. III, p. 468). He, however, regarded these lower pieces as the true basal pieces, and those above, usually considered the basals, as really being true subradial pieces. At one time we were inclined to adopt this conclusion, as has recently been done by Mr. BILLINGS, in an interesting paper on the structure of the *Blastoidea*, etc., published in the American Journal of Science and Arts for July, 1869. The fact, however, that these lower pieces *do not alternate with the range* above, that Mr. LYON'S view would require should be considered subradials, as in the Crinoids, provided with both basal and subradial pieces, would alone be an objection to this conclusion. It is also worthy of note that when these lower pieces are removed, we find the next range of pieces above closed together, so as to form the bottom of the visceral cavity. Again, in those species of *Granatocrinus*, like *G. Norwoodi*, with a deep concavity in the under side, we find the pieces corresponding to those Mr. LYON thinks are the subradials as it were, pushed inward, and forming a little pyramid in the bottom of the visceral cavity, precisely as we see the true basal pieces in various types of true Crinoids, with a deeply sunken base. In addition to this, although adult specimens of the type of the genus under consideration have these lower pieces as solid as we see them in the true *Pentremites*, young individuals show clearly *that they are actually composed of five or six of the upper joints of the column enlarged and anchylosed together*. The swelling out or enlargement of some of the upper joints of the column of a Crinoid, is no very uncommon occurrence—for instance, in such genera as *Forbesiocrinus*, *Poteriocrinites*, *Apiocrinites*, etc. It is true that in these and other similar cases, the enlarged upper joints of the column are not divided by vertical sutures, as in *Pentremites* and *Codonites*. This fact, however, will be seen to be of little importance, when it is remembered that the longitudinal division of the column by vertical sutures still does occur in some true Crinoids—as, for instance, in *Barycrinus*, in which the whole column is sometimes seen to be divided all the way down into five sections. And it is a significant fact that these five sutures in the column of *Barycrinus* exactly coincide with those separating its five basal pieces, exactly as the three sutures dividing the pieces into three basals coincide with those separating the three basal pieces in *Pentremites* and *Codonites*.

than the column below, and but slightly expanded above to the base, to which they are firmly anchylosed; in adult specimens perfectly solid, but in young specimens sometimes seen to be composed of five or six enlarged, anchylosed pieces of the column. Base considerably wider than high, with sides expanding upward so as to cause a more or less defined constriction at its connection with the supplementary base; more or less pentagonal in outline as seen from below; basal pieces proper, wider than high, two pentagonal and one hexagonal in form, the lateral margins being shorter than the others. Radial or fork pieces large, about two-thirds as wide as high, and extremely prominent in the middle; generally a little wider above than below, with a general suboval or nearly oblong outline, the superior lateral angles being, however, obliquely truncated by the interradial and anal pieces, and the lower end a little convex, or obtusely angular in outline at the middle; each with its narrow, pseudo-ambulacral (more properly brachial) sinus extending out to its very prominent middle. Anal and interradial pieces rather small, twice as long as wide, distinctly constricted in the middle; the former more obtusely angular or somewhat rounded, and often convex below; opening usually regarded as the vent, moderately large, rounded or a little oval, and piercing the anal piece a little below the middle.* Pseudo-ambulacral areas very narrow, with nearly parallel sides, pore pieces (properly recumbent arm pieces) about fifty on each side of the ambulacral furrow in a large specimen, all very shallow; lancet pieces lanceolate in form, thick, sloping laterally from a very narrow or linear ridge along the middle, which is the only part exposed, and forms the bottom of the ambulacral furrows when the pore pieces are in place; supplementary pore pieces, if any exist, unknown. So-called ovarian openings, commencing one on each side near the inner ends of the pseudo-ambulacral, or arm areas, and extending outward along the margin of a broad sulcus, and near the edges of these areas, for about half the length of the latter, as very narrow slits, widest at the inner end, where they connect with the inner ends of the internal compressed tubes under the areas.* Central hiatus very small, its covering pieces minute; ambulacral canals passing in under the little central disc into the central hiatus, each covered apparently all their length, in perfect specimens, by a double series of very minute, interlocking pieces, doubtless capable of being opened apart along the middle during the life of the animal. Surface in well preserved specimens ornamented with regular, moderately distinct striæ running parallel to the margins of the basal and radial pieces. Column below the upper anchylosed part forming the supplementary base, and pinnulæ unknown.

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* We have several times thought we could see evidences that the anal piece in this species is divided into three pieces That is, first by a transverse suture on each side of the anal opening; and the inner half along the middle by a longitudinal suture. We think we can scarcely be mistaken in regard to internal casts of *Granatocrinus Norwoodi*, showing evidences of this character. Whether or not it exists in the true *Pentremites*, we have been unable to determine

Hight of a medium size specimen, exclusive of the supplementary base, 0.80 inch; greatest breadth, 1.34 inches; hight of supplementary base, 0.17 inch; breadth of do., 0.30 inch; breadth of pseudo-ambulacra, or recumbent arms, about 0.08 inch.

In general form this species seems to be remarkably like *Pentremites inflatus*, Gilb., as figured by PHILLIPS in his Geol. Yorkshire, pl. 3, fig. 1; but as PHILLIPS' figure does not show the summit, and gives but a few words of description, we have no means of knowing whether or not it belongs even to the same genus.

Locality and position—Lower bed of the Burlington group, of the Lower Carboniferous series, at Burlington, Iowa. Some of the best specimens of this species we have seen belong to Mr. WACHSMUTH'S collection.

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* These slits seem, as it were, to cut off a thin slice from each of the edges of the anal and inter-radial pieces, as well as from the margins of the deep pseudo-ambulacral sinuses of the radials. These slices are thicker near the upper (inner) ends, where they sometimes become callus, and apparently anchylosed, in adult specimens, to the pores pieces, so as to give the pseudo-ambulacra the appearance of greater breadth there than is natural.

CODONITES GRACILS, M and W.

Pl. 8, Fig 6.

BODY comparatively rather small, pentagonal-suboval, longer than wide, the widest part being at the lower extremities of the so-called pseudo-ambulacral fields, which terminate a little below the middle. Supplementary base small, very short, or only appearing to be composed of a single tripartite joint of the column. Base low, or near three times as wide as high, expanding rapidly upward, and pentagonal as seen from below; basal pieces of moderate size, two pentagonal and one hexagonal. Radial pieces nearly twice as long as wide, with a general oblong outline, though they are a little wider in the middle than above or below, while the superior lateral angles are a little truncated by the anal and interradial pieces, and the lower end is either obtusely angular in the middle or somewhat rounded; all rather distinctly convex below the middle; so-called pseudo-ambulacral sinuses rather narrow and slightly tapering, extending down a little below the middle, where they each terminate at a little pointed projection directed out horizontally, so as to add to the pentagonal form of the body, as seen from above and below. Anal piece of moderate size, wider and more obtuse below than the interradials, and narrow above, with a comparatively large anal opening, nearly dividing it a little below the narrowest part. Interradials more than twice as long as wide, the widest part being below, while the central region is much contracted, and the upper somewhat dart-shaped, and, like that of the anal piece, in each a little concave, with a small tubercle occupying the middle of the concavity. So-called pseudo-ambulacral fields rather narrow; somewhat convex, with a mesial or ambulacral furrow rather wide and deep, particularly above the middle; pore or arm pieces about twenty-two on each side of each area. Lancet pieces very narrow, but thick, and rather deeply furrowed along the middle above, where they form the bottom of the ambulacral furrows; further down, the pore pieces close in so as nearly or quite to cover the lancet pieces. Openings usually called ovarian apertures, in the form of distinct elongated slits, widest at the upper end, and extending down apparently three-fourths the length of the pseudo-ambulacra so very close to the margins of the latter as scarcely to leave more than a very thin intervening space above, and apparently none below. Central hiatus very small, and doubtless covered by minute plates when entire. Surface distinctly ornamented with very regular, well defined striæ running parallel to the upper margins of the basal pieces and to the inferior and lateral margins of the radials. Along the margins of the pseudo-ambulacral areas, narrow, slightly flattened spaces are seen extending up the surface of the radial pieces, and corresponding to rather broad, deep furrows seen occupying the same positions on the last described species. (Column and pinnulæ unknown.)

Hight, 0.60 inch; breadth about 0.50 inch.

This species, although agreeing with the last in the important character distinguishing it from *Pentremites* and *Codaster*, differs so materially in form and other details as to render a comparison unnecessary. In general form, it much more nearly resembles true *Pentremites* than the typical *Codonites stelliformis* does.

Locality and position—Lower division of the Burlington group of the Lower Carboniferous, at Burlington, Iowa. Mr. WACHSMUTH'S collection.

GENUS GRANATOCRINUS, Troost.

GRANATOCRINUS MELONOIDES, M. and W.

Pl. 9, Fig. 1.

Granatocrinus melonoides, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 88.

BODY rather under medium size, globose in form. Base very small, nearly even with the prominent lower extremities of the pseudo-ambulacral areas. Radial pieces nearly equaling the entire length of the body, and divided almost to their base by the pseudo-ambulacral areas, each with a broad deep sulcus extending up on each side of the pseudo-ambulacral areas, the entire length; while between this sulcus and each lateral margin the surface swells out into a broad rounded ridge, widest near the middle of the body and narrowing upward and downward, these ridges on each two contiguous pieces being separated by a deeply sulcated suture. Interradial and anal pieces very small, subtriangular or cuneate-quadrangular, only about one-sixth the length of the body, measuring over the curve of the sides. Pseudo-ambulacral areas very narrow or sublinear, with sides parallel, equaling the entire length of the body, slightly impressed above, but quite as prominent as the immediate margins of the radial pieces on each side below, if not wider; pore pieces about fifty on each side of the mesial furrow; supplementary pore pieces unknown; lancet pieces apparently not exposed externally. Openings of the summit small, but not clearly seen in the specimen.

Body of the typical specimen 0.45 inch in hight; breadth 0.5 inch.

The surface of the typical specimen of this species is not well enough preserved to show fine markings, but another individual of apparently the same species shows the lower half of the radial pieces to be ornamented with rather fine granules, so as to look like fine transverse striæ under a magnifier, while a few stronger longitudinal striæ are also seen on this part of the body. In this specimen, however, the surface of the radial pieces is less convex between their lateral margins and the broad sulcus on each side of the pseudo-ambulacra than in the typical form.

In form and the narrowness of its pseudo-ambulacra this species reminds one of *G. Sayi*, of Shumard, but it is at once distinguished by the very much larger anal and interradial and shorter radial pieces of that species, as well as by the canaliculate character of the sutures between the latter, with a rounded ridge on each side of this suture. In the comparative size of its radial and interradial pieces, as well as in the canaliculated sutures between its radial pieces, it agrees more nearly with *G. melo*, of O. and S., but is not only distinguished from that species by its subglobose form, (a little wider than long), and merely even instead of concave base, but by its much more prominent pseudo-ambulacral areas below the middle of the body, and deep, broad, rounded sulci immediately on each side of these, and swollen surface between these sulci and the canaliculated suture separating the radial pieces. It moreover comes from the upper division of the Burlington group, while the vastly more common *G. melo* is only found in the lower beds.

Locality and position—Upper beds of Burlington group, Burlington, Iowa. Lower Carboniferous. No. 398 of Mr. WACHSMUTH'S collection.

GRANATOCRINUS PISUM, M. and W.

Pl. 9, Fig. 4.

Granatocrinus pisum, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 89.

BODY small, oval—subglobose, being slightly longer than wide. Base very small, rather deeply concave, and distinctly pentagonal in outline. Radial pieces long, truncato-subelliptical in general outline, with the lower end narrow, forming a nearly flat surface across between the pseudo-ambulacral fields, excepting below the middle, where these surfaces are concave; all divided nearly to their very bases by the pseudo-ambulacra, and without even the faintest trace of a furrow along up the sutures between their lateral margins. Interradial and anal pieces strongly incurved above, cuneate-subtrigonal in form and longer than wide, the length being about one-fourth that of the whole body, measuring over the curve of the sides. Pseudo-ambulacra narrow, or sublinear, with very nearly parallel sides, there being a slight taper from above downward; all quite as convex as the slightly raised linear margins of the radial pieces on each side; pore pieces about twenty-six on each side of the distinct mesial furrow, along which their inner ends are minutely crenate, comparatively rather large, and ranging obliquely outward and downward; supplementary pore pieces unknown; lancet pieces apparently not visible externally, unless it is along the bottom of the mesial furrow.

Summit, when the minute pieces that doubtless closed the central region are removed, with a pentagonal opening of about the size of the anal aperture; so-called ovarian pores very small, and situated one on each side of each interradial piece, and two others doubtless as usual opening into the anal aperture, which is nearly circular and much larger than the pores.

Surface finely granular, the granules being smaller and more crowded on a lanceolate area, extending up the radial pieces between the pseudo-ambulacra, and terminating just before reaching the interradials, and on each side, and above this space.

Hight of body, 0.30 inch; breadth, 0.28 inch.

This little species might be mistaken for a small specimen of *G. melo*, by a hasty observer. It may be readily distinguished, however, by its longer interradial pieces, less numerous and proportionally larger pore pieces, much more prominent pseudo-ambulacra, and particularly by not having even a trace of a linear furrow along up the sutures separating the radial pieces, and these pieces flat instead of convex across between the pseudo-ambulacra. The little projecting points at the bases of its pseudo-ambulacra are also directed more downward.

Locality and position—Upper part of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 397 of Mr. WACHSMUTH'S collection.

GRANATOCRINUS NEGLECTUS, M. and W.

Pl. 9, Fig. 3.

Granatocrinus neglectus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 90.

BODY small, varying from oval to subglobose. Base slightly projecting, pentagonal in outline. Radial pieces scarcely equaling two-thirds the entire length, and deeply divided by the pseudo-ambulacral areas. Interradial pieces more than one-third the length of the body, cuneate-subtrigonal in form. Anal piece of about the same size as the interradials, but its upper extremity is erect and distinctly projecting, so as to form around the anal opening protuberant margins. Pseudo-ambulacral areas narrow, with nearly parallel sides, almost equaling the entire length of the body, nearly as prominent as the slightly raised margins of the radial pieces on each side; pore pieces twenty-five to thirty on each side of the mesial furrow; supplementary pore pieces unknown; lancet pieces apparently not visible externally.

Mesial opening of the summit very small; so-called ovarian apertures minute, and situated one on each side of the interradial pieces; anal opening comparatively large, with very prominent margins.

Surface of the radial plates between the pseudo-ambulacral areas longitudinally granulo-striate, while that of the interradial and anal pieces is marked in the same way transversely with a downward curvature.

Length of one of the oval specimens, 0.36 inch; breadth, about 0.28 inch; breadth of pseudo-ambulacra, 0.05 inch. Length of a smaller, proportionately shorter specimen, 0.28 inch; breadth, 0.25 inch.

This is another species having much the general appearance of *G. melo*, from which, however, it is at once distinguished by its comparatively much larger interradial and anal pieces, flat spaces between the pseudo-ambulacra, without any furrow along the mesial suture, and its more protuberant base and anal pieces.

It is more nearly allied, however, to the last described species in several of these characters, though sufficiently distinct to be readily separated on comparison. For instance, its anal and interradial pieces are nearly twice as large as in that species. Again, its base is proportionally two or three times as large, and so protuberant as to be seen in a side view, instead of being concave; while its pseudo-ambulacral areas do not extend so far down, and the little projections of the radial pieces at the lower extremities of these areas point out horizontally, instead of being directed nearly downward, like five little legs, upon which the body stands when placed on an even surface, as in the last.

We have seen five specimens, all of which agree in the characters given.

Locality and position—Lower division of the Burlington group, at Burlington, Iowa. Lower Carboniferous. No. 396 of Mr. WACHSMUTH'S collection.

GRANATOCRINUS NORWOODI, O. and S. (sp.)

Pl. 9, Fig. 2.

Pentremites Norwoodi, OWEN and SHUMARD, 1850. Jour. Acad. Nat. Sci., Phila., 2d series, Vol. 2, p. 64, Pl. 7, Fig. 13. (1852,) Geol. Survey, Iowa, Wis. and Minn., p. 591, Pl. 5 A, Fig. 13

GENUS PALÆCHINUS, McCoy.

PALÆCHINUS GRACILIS, M. and W.

Pl. 10, Fig. 2.

Palæchinus gracilis, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 82

BODY small, and apparently oval or subglobose. Interambulacral areas a little convex. Interambulacral plates in seven rows at the middle, but apparently only the marginal rows of pentagonal pieces are continued to the upper and lower extremities of the areas, the intermediate hexagonal pieces running out at various distances between the middle and the ends of the areas; thickness of each about half the breadth of the largest; all ornamented with closely set granules, of which 25 to 30 may be counted on each of the larger pieces. Ambulacral areas slightly convex, and equaling in breadth the first and second rows of interambulacral plates on each side, composed of very short pieces, which are a little thinner than the interambulacral plates, and about three times as wide as long, the widest part of every alternate one being at the outer end, which is received into a little sinus in the adjacent marginal interambulacral plate (there being generally three of these little sinuses to each of these plates), while the intermediate pieces usually wedge out rather abruptly before quite reaching the lateral margins; the two pores at the outer end of each piece arranged so as to form two zigzag or undulating rows along the lateral margins of each ambulacral area; surface of the whole series occupied by granules of the same size as those of the interambulacral plates.

Entire dimensions unknown; greatest breadth of inter-

ambulacral areas, 0.76 inch; do. of ambulacra, 0.22 inch; number of ambulacral pieces in 0.10 inch on each side of the mesial suture, 10.

This species will be readily distinguished from our *P. Burlingtonensis* by the proportionally greater breadth of the ambulacra, and the smaller size, and greater number of its interambulacral pieces, there being seven rows of the latter pieces at the widest part of the area, at a point equaling the breadth of these areas in *P. Burlingtonensis*, where there are only four or five rows of these pieces. Again, its ambulacral areas are equal in breadth to the first and second rows of interambulacral plates on each side, taken together; while those of *P. Burlingtonensis* are scarcely wider than the single marginal row on each side.

Locality and position—Upper division of the Burlington group, Burlington, Iowa. Lower Carboniferous. No. 407 of Mr. WACHSMUTH'S collection.

Note on the GENUS ONYCHASTER, M. and W.

THE borrowed specimens from which we made out the outline cuts and description of this type, published in the third volume of the Illinois Geological Report, p. 526, had been, to a great extent, denuded of their outer covering in cutting away the rather hard, firmly adhering matrix, before coming into our hands. Since preparing these cuts and description we have had an opportunity to examine other specimens of this fossil, in part belonging to Mr. WACHSMUTH'S collection, and others among the collections at Springfield, all from the original locality. From these it is evident that, in well preserved examples of this type, the granular outer covering seen on the arms or free rays of some of the specimens first examined, actually covers the dorsal side of the small body also. We likewise observe the presence of a layer of thin, small, imbricating scales under the scattering granules on the dorsal side of the body; while some specimens certainly show clearly such scales under the granules on the arms. The fact that this granular covering, and this layer of thin imbricating scales, overspread the dorsal side of the body, would certainly show that the appearance of a large central, dorsal opening, which we had marked as an "anal?" aperture, could not be such. The appearance of pores in some of the pieces around the central opening is also deceptive, and due rather to deep pits than to actual perforations passing through these pieces.

From the specimens we have since had an opportunity to examine, we are led to think it almost certain that the parts seen around the central opening in the specimen illustrated by us are the oral and adjacent pieces accidentally pushed upward, and seen from the upper or inner side after the removal of the dorsal side or covering, and that the central opening is the oral aperture. At any rate we know of no other way to account for the very different appearances presented by these fossils, when examined in different conditions.

Since we have had some specimens of this type at hand which we have felt at liberty to grind and cut into, so as to reveal more clearly their structure, we find that the arm-pieces, which in the denuded specimen first examined by us presented the appearance of becomiug isolated, deeply furrowed lanceolate pieces, at a little distance from the body, and of very little thickness or depth, really appear, when ground off, to extend nearly all the way down from the dorsal to the ventral sides of the arms, and to be connected and articulated together, like those nearer the body, by little processes and sockets; the comparatively thin furrowed dorsal edges becoming thicker farther in.

Sometimes these arm-pieces appear as if consisting of two rows joined in pairs at their inner ends along the middle of the dorsal side, there being a rather large pore (or possibly only a deep pit) at the junction of the two pieces forming each pair. In other instances, as seen detached, these pairs of pieces are found to be firmly anchylosed so as to form single pieces, extending across the whole breadth of the arms, without, however, obliterating the appearance of a rather large mesial dorsal pore.

We have not yet had an opportunity to see the under side of the body or arms in any of the Crawfordsville specimens, but Mr. WACHSMUTH has a specimen from the Burlington division of the Lower Carboniferous beds of Burlington, which would seem to belong to this genus, though specifically distinct.* This is the form Prof. Hall has described in some preliminary notices of fossils (issued at Albany, N. Y., in 1861), under the name *Protaster? Barrisi.* This fossil has, so far as we have been able to see, essentially the same structure, and shows along the under side of the arms a broad shallow depression in the arm-pieces, somewhat like an ambulacral furrow. None of the specimens of either species we have seen show any indications of any proper extended disc, the body being comparatively small. It also evidently differs in several points of structure from *Protaster.*

So far as its structure is yet known, it seems to be a true *Ophiurian.* We only know the species *Onychaster flexilis* and *O. Barrisi.*

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* We have not yet, however, seen any of the little articulating knobs on the scales of this Burlington species. These impart the granular appearance to the surface of our typical species, in which each scale has one of these little knobs articulated in its middle. If the Burlington species did not have these, it may belong to another, but allied genus.

ONYCHASTER BARRISI, Hall, sp.

Pl. 10, Fig. 1.

Protaster Barrissi, HALL, 1861. Desc. New Crin., Prelim. Note, p. 18.

Locality and position—Burlington division of the Lower Carboniferous. Burlington, Iowa. Mr. WACHSMUTH'S collection.

GENUS OLIGOPORUS. Meek and Worthen.

OLIGOPORUS NOBILIS, M. and W.

Pl. 11, Fig. 3.

Oligoporus nobilis, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1868, p. 358

BODY large, globose, composed of very thick plates. Ambulacra nearly flat or slightly convex, and without proper furrows, narrow lanceolate in outline, or only about two-thirds as wide as the interambulacral areas; pore pieces comparatively small, wider than high, those of the two outer rows rather more irregular in size, and some of them a little larger than any of those of the two inner rows; pores two to each piece, forming four double rows, those of the two outer ranges of pieces being placed near their inner ends, and those of the inner ranges near their outer ends. Interambulacral areas comparatively large, moderately convex, and composed of five rows of large plates, all of which extend to the disc above, while the middle one ends within about 0.65 inch of the oral opening below. Vent and apical disc much as in *Melonites multipora*. Surface of all the plates, both ambulacral and interambulacral, ornamented with coarse granules, separated by spaces generally a little wider than their own breadth, with sometimes a few smaller ones between. Of these granules, about forty to sixty may be counted on each of the larger interambulacral plates.

Hight and breadth, about 3.73 inches; breadth of ambulacral spaces, 0.60 inch; do. of interambulacral areas, 1.06

inches. Hight of largest interambulacral plates, 0.26 inch; breadth of do., 0.40 inch; thickness of do., 0.25 inch.

The only specimen of this fine species yet known to us is mainly a silicious cast of the interior. The connection of the plates, however, are so distinctly defined by sharply raised lines, formed by the silicious matter deposited in the sutures between all of the pieces before they were dissolved, that the entire structure can be made out as well as if the plates themselves had been preserved. A few of the plates, however, or rather casts of their external surface, remain so as to show the surface granules as well as the thickness of the plates themselves.

The apical disc seems to be very similar, as already stated, to that of *Melonites multipora*—the arrangement and comparative sizes, as well as form of the occular and genital plates, being much the same. In two of the latter, five pores may be counted in each, while one other also shows obscure indications of five pores and the other two had four each, as near as can be made out from the little projecting points representing them in the cast. No satisfactory indications of pores, however, are to be seen in the occular pieces.

Although the ambulacral areas are not properly furrowed, as in *O. Danæ* and *Melonites multipora*, they are slightly depressed below the most convex central region of the interambulacral areas. The depression, however, also includes the two marginal rows of each interambulacral series. There is likewise a faint, narrow, almost linear impression on the internal cast, extending from the apical disc about half way down the middle row of plates in each interambulacral field.

This form can be at once distinguished from *O. Danæ*, the only other known species of this type, by its proportionally much larger and less numerous interambulacral plates, of which there are only *five* instead *eight or nine* rows to each area. Its ambulacral areas are also proportionally narrower, and, as already stated, differ in not being furrowed along each side, with a ridge along the middle.

As we have elsewhere suggested, the group *Oligoporus* seems to be exactly intermediate in its characters between *Melonites*, Owen and Norwood, and *Palæchinus*, (Scouler) McCoy. That is, it differs from *Palæchinus* in having *four* rows of ambulacral pieces and four double rows of pores, instead of *two* of each, as well as in having the ambulacral areas more or less sunken below the interambulacral fields. In the last character it agrees more nearly with *Melonites*, from which, however, it differs widely in having only *four* rows of ambulacral pieces and *four* double rows of pores, instead of *ten* of each to each area. In the nature of its apical disc the species under consideration shows that in this type it agrees well in its general characters with *Melonites*. We also know, from a crushed specimen of *Oligoporus Danæ*, that the species of this group have the jaws very like those of *Melonites*. The question may therefore arise whether or not these differences in the *number* of pieces and pores of the ambulacra are of generic importance, and whether we ought not to regard them as only subgeneric, and call our species *Melonites (Oligoporus) nobilis*. On the same grounds, however, we would have as good reason to regard both *Oligoporus* and *Melonites* as mere sections or subgenera of *Palæchinus*. We cannot, however, believe so important and constant a difference of less than generic value, no gradations being yet known in this character between *Oligoporus* and *Melonites* on the one hand, or between the former and *Palæchinus* on the other. It is true, we yet only know one species of *Melonites*, but we now know two well marked species of *Oligoporus*, while there are eight or nine known distinct species of *Palæchinus*, all of which latter agree in having but two rows of ambulacral pieces to each area.

At the time we proposed the name *Oligoporus* we were not aware that Prof. DESOR had designated a section (not a genus) of the family *Cidaridæ* by the name *Oligopores*. In case this should be regarded as a serious objection to our name *Oligoporus* we suggested, in the second volume of the Illinois Geological Reports, the name *Melonopsis* for this group instead; and if it should be adopted, the species here described would have to be called *Melonopsis nobilis*. The name *Oligopores*, however, from its different termination, we should think sufficiently distinct.

Locality and position—Calhoun county, Illinois; from the Burlington division of the Lower Carboniferous series.

GENUS EOCIDARIS.

EOCIDARIS? SQUAMOSUS, M. and W.

Pl. 9, Fig 15.

Eocidaris? squamosus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 79

BODY attaining a large size, apparently depressed subglobose in general form. Interambulacral plates rather thick, in eight or more longitudinal rows near the middle of each area,* but apparently only the two outer rows continued to the oral apertures, all presenting the usual hexagonal form, excepting the pentagonal marginal rows, and distinctly imbricating apparently from the lower side upward,* as well as inward toward the central row, excepting the two outer rows on each side, the lateral imbrication of which is outward—that is, the outer row laps the edge of the ambulacral series, and the next range laps the edge of the outer row, while its inner edge laps that of the next row within, and so on to the middle row, which is lapped on both sides; each with a comparatively large, smooth, saucer-shaped depression, occupying the central region, from the edges of which the surface is distinctly beveled off in every direction to the margins, the beveled edges that pass under the edges of the adjacent plates, however, being distinctly wider than those lapping the adjacent pieces, these lapping edges being as if ground off obliquely under, or, in other words, beveled on the inner side; tubercles for the support of the primary spines smooth, prominent, rather large, and rising in the middle of the saucer-shaped central depression, narrowing upward to near the top, where there is a circular depression surrounding a very narrow, prominent, perforated, central process for the immediate articulation of the primary spines; most convex part of each plate surrounding the smooth, saucer-shaped depression, ornamented with a few very small pustules, upon which small secondary spines probably articulated. Primary spines apparently one inch or more in length, rounded, slender, and nearly or quite straight, with the articulating end perforated and a little enlarged, so as to form an undefined ring. Surface ornamented with minute, crowded, longitudinal striæ, only visible by the aid of a good magnifier. Ambulacra narrow, or nearly about equaling the breadth of the marginal rows of interambulacral plates on each side, slightly convex. Ambulacral pieces slightly imbricating in the opposite direction from the interambulacral series, of very unequal size and form, and irregularly arranged, most of those starting from the mesial, zigzag suture extending out so as to connect with the crenated, lapping margins of the outer ranges of interambulacral plates, while many of those starting from the latter inward, wedge out more or less abruptly between the others, at various distances, before reaching the mesial suture, so as to present the appearance of a strong tendency to run into two rows of pieces on each side of the mesial suture, each pierced by two pores, which, owing to the irregular arrangement of the plates, present the appearance of forming two double rows along near each lateral margin of each ambulacrum, or four rows to each of these areas. They might, however, with probably almost as much propriety, be counted as one double, strongly zigzag row on each side.

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* Eight rows are seen in the specimen at the widest part, but we are not sure this is the middle of the area, owing to the imperfection of the specimen.

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* This imbricating character, as well as several others mentioned in the above description, may be of more than specific value, and they are mentioned here along with specific characters because we are in doubt in regard to the generic relations of the fossils.

Near what appears to be the position of the oral opening there is adhering to the specimen one-half of a stout jaw, 0.60 inch in length. On its outer side it is cuneiform, a little arched, and provided with a broad, longitudinal, excentric furrow; its lateral margins are smooth, and near 0.30 inch in breadth at the base, and converge to a sharp edge within. We have now tolerable good evidence that all the different genera of the *Perischechinidæ* are provided with strong jaws.

The specimen is too imperfect to give a good idea of its general form or size. As it shows one of the interambulacral areas, however, to be near two inches broad, it is probable the entire fossil was not less than four and a half inches in its transverse diameter. The largest interambulacral plates measure about 0.35 inch in length and breadth, while those of the outer rows next the ambulacra are proportionally narrower. The primary spines seem to be about one inch or more in length, though we have seen none entire. The longest fragments we have seen are about 0.50 inch long, 0.10 inch thickness at the articulating end, and 0.06 inch in diameter a little above, but without any taper toward the broken end. The ambulacral areas are only about 0.26 inch in breadth at the widest place, near the middle, and about four to six of their pieces fit into the crenulations of each of the marginal interambulacral plates.

We have been somewhat puzzled in regard to the generic characters of this species. Its interambulacral plates are each provided with the large central tubercle and spine, characterizing *Archæocidaris* and *Eocidaris*, though these tubercles agree with those of *Eocidaris* in having no ring or slight projection around the base, as in *Archæocidaris*. At first we were inclined to believe it related to Prof. HALL's genus *Lepidechinus*, on account of the decidedly imbricating character of its plates; but judging from the brief published description of the type of that group (which has not yet been figured,) it would seem to belong even to a different family or sub-family, as nothing is said in the description of that type in regard to a large central tubercle for the articulation of a larger spine on each of the interambulacral plates, the surface being, on the contrary, merely described as crowded with "irregular granules." In addition to this Prof. HALL places his group as a subgenus under *Palæchinus*, one of the distinguishing features of which is the presence of numerous small, imperforate tubercles covering all the plates, without any larger central perforated tubercle.

It is worthy of note, however, that Prof. HALL has since figured another species (*L. rarispinus*, Twentieth Rep. Regents' Univ. N. Y. on State Cab. N. H.) in which *some* of the interambulacral plates are provided with a large central tubercle, while others apparently have none. We are not informed whether these larger tubercles are perforated at the end, as in *Archæocidaris* and *Eocidaris*, or whether they are without such perforation, as in *Palæchinus;* but if it belongs to the same *family* as that including *Palæchinus*, of which *Lepidechinus* is supposed to be a sub-genus, it is almost certain that its tubercles are not perforated.

At any rate, our fossil differs from *L. rarispinus* in the following characters, that seem to be of more than specific importance. In the first place, it differs materially in the very irregular nature of its ambulacral pieces, which show a strong tendency to pass into, and in fact do, at some places, actually pass into two rows on each side of the mesial zigzag suture, instead of having clearly but a single row on each side, with each piece extending entirely across from the mesial suture to the lateral margins. Again, it differs in having a large central tubercle and spine on *each one* of all the plates of the *entire* interambulacral series. The lateral imbrication of the plates in our type is also different, the direction of the imbrication being inward, excepting in the two outer rows on each side, instead of outward in the whole series, the middle row being clearly lapped on each side, instead of lapping those on each side of it.

The strongly imbricating character, especially of the interambulacral plates in our type, is a very marked feature throughout; the lapping edges being somestimes at least one-fourth the entire breadth of these pieces, and yet, owing to the accuracy with which they are beveled, they lie so evenly together that this peculiarity is scarcely apparent where the plates have not been displaced. We are not aware whether this imbricating character of the plates has been observed in any of the European types on which the genera *Eocidaris* and *Archæocidaris* were founded.[*] It is certainly more or less marked, however, in several of the American forms now before us that have been referred to the latter genus. For instance, it is clearly seen in the typical specimen of *A. Agassizi*, of Hall, and less distinctly in his *A. Shumardi*. We can also see indications of it in *A. Wortheni*, of Hall, though owing to the thinness of its plates the beveling of their edges is less apparent. All these species have the peculiar ring or prominence around the base of the tubercles supporting the primary spines, seen in the true *Archæocidaris*, and distinguishing it from *Eocidaris*. It seems, therefore, probable that this character *may* be more or less marked in both *Archæocidaris* and *Eocidaris*, but most apparent in species which, like that we have here described, are provided with plates of more than the usual thickness.[†]

So far as we are aware, no European species of *Eocidaris* showing the structure and arrangement of the ambulacral series of pieces has been discovered; at least we have seen no figures or descriptions of such. Prof. HALL, however, has described a species from the Chemung group of New York (Twent. Rep. Regents' Univ., p. 298,) to which VANUXEM had given the name *Echinus Drydenensis*, but which is said to be an *Eocidaris*. In this the ambulacral plates are described as being in two ranges without any intercalated pieces, if we understand the description correctly.

From all that is therefore known in regard to the several types mentioned, we are much inclined to believe that our fossil will be found to belong either to a distinct sub-genus under *Eocidaris* or to an allied new genus. In either case we would propose for the group the name of *Lepidocidaris*.

Locality and position—Lower bed of the Burlington group, of the Lower Carboniferous, at Burlington, Iowa. No. 404 of Mr. WACHSMUTH'S collection.

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[*] Some of Prof. DESOR'S figures of the plates of *Eocidaris* appear to show indications of marginal beveling, while others do not.

[†] Since this was written we have been led to believe this imbricating character of the plates is more or less defined in all the *Archæocidaridæ* as well as in some of these older types apparently not belonging to that family

FOSSILS OF THE KEOKUK GROUP.

GENUS BARYCRINUS, Wachs.

BARYCRINUS MAGNIFICUS, M. and W.

Pl. 12, Fig. 2.

Barycrinus magnificus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1868, p. 340.

BODY attaining a gigantic size, cup-shaped, or widening rather rapidly, with moderately convex sides from the column to the top of the first radials. Base shallow, basin-shaped, or about four and a-half times as wide as high, with a large concave facet for the attachment of the column, and a large, obscurely five-lobed perforation for the connection of the central cavity of the column with the visceral cavity of the body. Basal pieces regularly pentagonal. Subradial plates about five or six times as large as the basal pieces, as wide as long, or slightly wider, all regularly hexagonal, excepting one on the anal side, which is a little shorter than the others, and truncated above for the reception of the anal piece, so as to present a general heptagonal outline. First radial pieces about one-third wider than high, and larger (particularly wider) than the subradials, each presenting a general pentagonal outline, and provided with a rather shallow, outward sloping, concave facet, occupying more than one-third its entire breadth, for the reception of the succeeding radials. Second radial pieces very much smaller than the first, extremely short, or only about one-fourth as long in the middle as wide, and becoming much thinner, or wedge-shaped, on each side.

Third radials a little longer in proportion to their breath than the second, and presenting a subtrigonal outline, supporting on their sloping upper sides, broad, short, rounded arm-pieces. Anal piece about half as wide and nearly of the same length as the first radials, and subquadrangular in form. Surface marked with small pustules, which often become confluent, so as to produce a peculiar corrugated roughness, somewhat similar to the ornamentation we see on the body plates of the true *Amphoracrinus*, but coarser.

Breadth of body, 3.33 inches; hight of do., 2.20 inches; breadth of base, 0.60 inch; breadth of facet for the reception of the column, 0.85 inch; do. of largest first radial piece, 1.70 inches; hight of same, 1.30 inches. Thickness of one of the arms at base, 0.70 inch.

This splendid Crinoid was found by Mr. Green, of the Illinois Survey, with its plates detached and lying near together in the rather soft matrix. After working out the pieces, we succeeded in building up the entire body to the third radials and first arm pieces, inclusive, excepting the anal piece, which was not found. It presents a very striking appearance, and is the largest Crinoid we have ever seen. If its arms were as long in proportion as those of some other species of this group, they must have been near twelve inches in length, and with its column, body and arms together, it may have been more than four feet in hight. It is evidently related to *Barycrinus magister*, Hall (sp.), but differs from that species, the type of which is now before us, in having its surface roughened by numerous small pustules, showing a tendency to run together into vermicular markings, with an obscure effort, on some of the plates, to assume a radiating arrangement. It is true, the typical specimen of *B. magister* consists of only the basal pieces and a portion of the column, but these basal plates show no traces of the peculiar surface markings seen even on the base of our species, while we have before us, from the same original locality, another specimen of that species, consisting of the whole body, in a flattened and crushed condition, and, although the surface of its plates is well preserved, they show no indications whatever of the surface markings seen on our species.

Those who give a wide latitude to genera will probably not regard such forms as this as being generically distinct from *Cyathocrinus;* even if that view should ultimately prevail, however, we should insist upon their separation as a strongly marked subgenus, and continue to write the name of our species *Cyathocrinites* (*Barycrinus*) *magnificus.*

Locality and position.—Henderson county, near Biggsville, Illinois; from the Keokuk group of the Lower Carboniferous.

BARYCRINUS GEOMETRICUS, M. and W.

Pl. 12, Fig. 3.

(See Vol. III, page 518, of these Reports, for description of an undetermined species of *Cyathocrinus?* also same, Pl. 20, Fig. 5.)

Locality and position—Keokuk division of Lower Carboniferous, near Warsaw, Illinois.

BARYCRINUS HOVEYI, var. HERCULEUS, M. and W.

Pl. 13, Fig 2

Barycrinus Hoveyi, var. *Herculeus*. MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1868, p. 341

Amongst other Crinoids from Crawfordsville, Indiana, we have before us several very large, fine specimens, agreeing well with Professor HALL'S description of his *Cyathocrinus Hoveyi* (Bost. Jour. Nat. Hist., Vol. vii, p. 293), excepting in some important points in the structure of the arms. We suspect that these specimens are specifically distinct, but as neither any measurement, nor figures of the *C. Hoveyi*, have yet been published, we cannot feel quite sure of this, and therefore place them, provisionally, as a variety of the species *Hoveyi*, under the name *Herculeus*, which we propose to retain for the species, if the differences to be noted are found to be constant and of specific value.

The differences to which we allude are the following: In *C. Hoveyi* the arms of the antero-lateral rays are said to "have the anterior division twice bifurcating, above which the divisions give off branchlets, and the same feature marks the entire length of the lateral arm of the antero-lateral ray, which is smaller than the other." In the specimens before us the anterior lateral rays have each the *posterior* division bifurcating *once* near the base, while the anterior division is *simple* and *larger*, instead of smaller, than the other. Again, the *Hoveyi* is said to have, "in the postero-lateral arms, the lateral division of the rays bifurcating on the fourth piece, above which branchlets are thrown off, as in the others." In the specimens before us, however, *both* arms of the posterior rays are, like those of the anterior ray, and one of each lateral (or anterior lateral) rays, simple from their origin on the third radials, very long, stout, and give off along their inner lateral margin stout, simple armlets, alternately at regular intervals. As we have seen several specimens all agreeing in these characters, we are inclined to think this may be a specific difference.

In one of the specimens before us the body measures 1.10 inches from the base to the top of the first radials, and about 1.40 inches in breadth. The arms show a length of 4 inches, and are broken at the ends so as to appear to have been, when entire, nearly, one inch longer. They are very straight, nearly cylindrical, and measure 0.22 inch in diameter near the middle, where each arm-piece measures about 0.15 inch in length, and the lateral armlets nearly the same in diameter.

Barycrinus Hoveyi, Hall, sp.

Pl. 13, Fig. 1.

Cyathocrinus Hoveyi, Hall, 1861. Descr. New Crin., Prelim. Notice, p. 5, and Boston Jour. Nat. Hist., Vol. VII. p. 298.

Locality and position.—Crawfordsville, Indiana. Keokuk division of the Lower Carboniferous series.

Barycrinus mammatus, Worthen, Ms.

Pl. 15, Fig. 4.

Body rather below the medium size, cup-shaped or subhemispherical. Base small, slightly protuberant, and truncated for the reception of the first columnar joint; the basal plates projecting more than half their length beyond the columnar facet. Subradial pieces about as long as wide, all hexagonal, slightly impressed at their angles, and produced into a small mammiferous node near the centre of each. First radials pentagonal, wider than long, the one on the anterior side smaller than the others, all slightly convex, but not protuberant; second radials very short and as wide as the first; third radial, as seen on one ray, about twice as long as the second, and giving off two arms from its upper sloping angles. Anal plate rather small, and quadrangular. Surface of all the body pieces finely rugose.

This species is closely related to *B. protuberans*, Hall, sp., Geol. Survey of Iowa, Vol. I, part 2, p. 626, Pl. 18, Fig. 9, but differs from that in the more delicate protuberances on its subradial pieces, and the non-protuberant character of its first radials.

Locality and position.—Keokuk division of the Lower Carboniferous series. Otter creek, Jersey county, Illinois.

BARYCRINUS PENTAGONUS, Worthen, Ms.

Pl. 15, Fig. 3.

BODY of medium size, broadly subglobose, and pentagonal in outline when seen from below, gradually swelling from the base to the top of the first radials. Base pentagonal, depressed in the center, composed of nearly equal sized, thick, pentagonal plates, strongly depressed at the angles, giving a stellate outline to this part of the body. Subradials large, width and highth about equal, the one on the anal side rather the largest, and septagonal, the others hexagonal, all deeply impressed at the angles, and gradually swelling to a point a little above the center of each plate. The depression at the sutures of the basal plates extends nearly to the center of the subradials, forming a stellate depression when viewed from below, the points of which terminate near the center of the subradials, as may be seen in fig. 3 a. Radial plates unequal in size, wider than high, and like the subradials strongly depressed at the angles, and deeply excavated above for the reception of the second radials. Anal plate quadrangular, about half the size of the first radials, and extending a little above the summits of those on either side. Arms and column unknown.

Position and locality—Keokuk Limestone, Otter creek, Jersey county, Illinois.

BARYCRINUS SUBTUMIDUS, M. and W.

Pl. 13, Fig. 3.

Barycrinus subtumidus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., Aug., p. 151.

BODY below the summit of the radial pieces cup-shaped, robust, rather deep, somewhat rounded below, with nearly vertical sides above the subradial pieces. Basal pieces well developed, pentagonal, convex, and about as wide as long. Subradials four or five times as large as the basal pieces, thick, and strongly convex, slightly higher than wide, four hexagonal and one apparently heptagonal. First radial plates about the size of the subradials, having a general pentagonal outline, with the two superior lateral angles more or less truncated apparently by the first vault pieces; not tumid like the subradials; each with a moderately concave, outward-sloping facet, for the reception of the next range of radials. Succeeding primary radial pieces (of which one ray shows two and another three) about half as wide as the first radials; all rounded on the back, two in one ray and one in another, transversely oblong; the last one in each of these rays proportionally a little larger than the others, pentagonal in form, and supporting on its superior sloping sides the arms, which, in the anterior ray, bifurcate again on the second piece, beyond which the arms, in the typical specimen, can be traced a short distance without showing further bifurcation. (Number and arrangement of the anal series unknown.)

Breadth of body (allowing for compression), about 1.40 inches; hight to top of first radials, 1.10 inches.

This species is somewhat similar in its general characters to such forms as *C. bullatus* and *C. protuberans*, of Hall, (Iowa Report, pp. 624, 626,) but differs from both in having its basal pieces proportionally much larger, narrower and proportionally longer. From *C. protuberans* it also differs, in not having its first radial pieces tumid, while one of its arms is seen to divide again on the third piece after the first division on the third radial, instead of merely giving out small lateral branches, as in that species.

Our specimens being defective on the anal side, we are not quite sure as to the nature of the anal parts, though there seems to have been, as is usual in *Barycrinus*, only one anal piece between the first radials.

Location and position—Keokuk Limestone, of the Lower Carboniferous series, near Whitehall, Greene county.

CYATHOCRINITES? POTERIUM, M. and W.

Pl. 12, Fig. 4.

Cyathocrinites? poterium, MEEK and WORTHEN, 1870. Proceed. Acad. Nat. Sci., Phila., p. 24.

BODY small, depressed, subglobose, somewhat flattened below and contracted above. Basal plates of moderate size, pentagonal in form, and spread out horizontally so as form a nearly flat pentagonal disc, excepting that the salient angles are curved upward a little; facet for the attachment of the column small, compared with the size of the base, round, and not impressed. Subradial plates large, forming the widest part of the body, convex on the outside, but not from thickening; about as wide as long, hexagonal, with perhaps the exception of one on the anal side, of heptagonal form; all curving under below to connect with the base. First radials somewhat smaller than the subradials, wider than long, pentagonal in form, and provided above with very small, shallow sinuses for the reception of the second, which are small, but more than filling the shallow sinuses. Third radials, in two of the arms seen, small, and bearing on each of their superior sloping sides a long, very slender, subcarinated arm, which bifurcates on the second piece above, while the divergent divisions subdivide two or three times again above, at intervals of three or four pieces; the divisions and subdivisions all being very slender, and composed of joints about twice as long as wide. In two of the rays seen, however, the free arms are simple from their origin on the first radials—at least as far up as to the sixth piece, inclusive, (which is as far as they can be traced in the specimen,) and present the remarkable character of having the second, third and fourth pieces greatly dilated, or alate on each side, so as to be nearly two-thirds as broad as the whole body below, though the first piece next the body (second radial) is narrow, and nearly twice as long as wide, as are the fifth and sixth pieces. Surface smooth, or only finely granular. Sutures close fitting, or not channeled. Anal plate and column unknown.

Hight of the body, 0.20 inch; breadth of do., 0.34 inch; breadth of the dilated part of one of the simple arms, about 0.22 inch. (See note below.)

Position and locality—Keokuk group; Crawfordsville, Indiana.

GENUS POTERIOCRINITES.

POTERIOCRINITES (ZEACRINUS?) CONCINNUS, M. and W.

Pl. 14, Fig. 3.

Poteriocrinites (Zeacrinus?) concinnus, MEEK and WORTHEN, 1870. Proceed. Acad. Nat. Sci., Phila., p. 26.

BODY wider than high, rather rapidly expanding upward from the column. Base small, basin-shaped, about three times as wide as high, and truncated about three-fourths its breadth below by the facet for the attachment of the column. Basal pieces wider than high, pentagonal in form, and expanding upward from the column, which is rather stout, round, and composed near the base of thin pieces. Subradials of moderate size, not thickened or tumid, four

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NOTE.—It is possible that the dilated arms may bifurcate above the sixth piece, though the specimen from which the description was made out is not in a condition to settle this point. The fact that they become suddenly narrow above the fourth piece, would seem to indicate that they may possibly assume the character of the other arms further up. As seen lying partly imbedded in the matrix, with the long jointed, slender arms, and their branches incurved above the little globular body, the whole reminds one very much of the Jurassic genus *Saccosoma*, Agassiz.

The very remarkable characters of the arms in this little crinoid, if not due to abnormal development, would certainly seem to warrant its separation, at least sub-generically, from the typical forms of *Cyathocrinites*. It also seems very improbable that its ventral disc is constructed as in the typical forms of this genus. Should other specimens show the peculiarities we have mentioned to be normal, we would propose for this type the generic or sub-generic name *Saccosomopsis*.

Specifically, this form, at least so far as regards its body, seems to be exactly like a species described by Prof. HALL, under the name *Cyathocrinus parvibrachiatus* (Jour. Bost. Soc. Nat. Hist., Vol. VII, p. 395, 1861,) and it is worthy of note that he describes its "subbrachial" or free radial pieces as being "two to each ray, broad and strong, but varying in the different rays." As these pieces "*vary in the different rays*," may not those he saw, that were broad and strong, have belonged to dilated, simple rays, as in our species, and these rays been broken off above the second pieces in the specimen described? If so, his species would almost certainly belong to the same group as ours, but differs specifically in having its bifurcating arms shorter, more radidly diminishing in size, with shorter pieces between the bifurcations, so as to bring the subdivisions closer together; also in having larger and deeper sinuses in its first radials for the reception of the second.

We are much inclined to believe there is a little group of species having essentially the form of body and the peculiarities of the arms we have described, and that it will probably include *Cyathocrinus Saffordi*, the arms of which are unknown.

hexagonal, and one on the anal side heptagonal. First radials as wide as the subradials, but shorter, pentagonal and truncated their entire breadth above. Second radials as wide as the first, but scarcely more than half as long, all transversely oblong in form. Third radials in the posterior and anterior lateral rays, of nearly the same form and size of the first, but of course with sloping sides above. On these sloping sides they each support two unequal arms, the posterior one of which in one of the posterior lateral rays is smaller than the other, and can be seen to bifurcate on the fourth piece, while the other bifurcates on the second piece, and its subdivisions divide again at various distances above several times, so as to make altogether about thirteen or more subdivisions in this ray. The anterior main division of one of the anterior lateral rays can also be seen to bifurcate on the fifth piece above the third radial, and one of its branches subdivides at different distances above into three subdivisions, and the other into four. Anterior ray simple to the eighth piece, the pieces between the first and last being short and somewhat wedge-form, while the last is pentagonal, and supports two arms, each of which can be seen to bifurcate at least once some distance above. Anal pieces with the usual double, alternating arrangement, the lowest piece being obliquely inserted between the upper sloping sides of two of the subradials, and partly under one side of one of the first radials, while a contiguous piece on the left above is supported on an upper truncated side of one of the subradials, and the latter are succeeded by others that connect with the base of the proboscis. Arms long, slender, straight and gradually tapering; slightly convex on the dorsal surface, and flattened so as to fit closely together on each side, with all their divisions running up parallel, or showing scarcely any divergence at the bifurcations, and all composed of short wedge-formed pieces; axillary pieces not more protuberant than the others. Pinnulæ small, and arising one from the upper part of the longer side of each arm piece, alternately on each side, and rather closely approximated to each other. Surface in well preserved specimens, finely and obscurely granular, the granules showing on the arms (as seen under a magnifier) a tendency to arrange themselves in longitudinal rows, or to assume vermicular forms. Sutures between all the pieces merely linear.

Entire length of arms and body, 2.80 inches; hight of body to the top of first radials, 0.27 inch; breadth, about 0.43 inch; thickness of column at its connection with the base, 0.17 inch.

This species seems to combine, to some extent, the characters of *Poteriocrinus* and *Zeacrinus*. In general, especially in the somewat flattened and closely contiguous characters of all the divisions of its arms all around when folded together, as well as, to some extent, in their mode of division, it reminds one of many species of *Zeacrinus*. In the form of its body, however, and particularly in having three primary radials instead of only two in each of the anterior and posterior lateral rays, and about eight below the first bifurcation in the anterior ray, as well as in the general form of its body, it agrees more nearly with the typical forms of *Poteriocrinus*. We know of no species liable to be confounded with this, when specimens can be seen with its arms well preserved.

Locality and position—Keokuk division of the Lower Carboniferous series; Crawfordsville, Indiana.

SUBGENUS SCAPHIOCRINUS.

SCAPHIOCRINUS DEPRESSUS, M. and W.

Pl. 14, Fig. 8.

Scaphiocrinus depressus, MEEK and WORTHEN, 1870. Proceed. Acad Nat. Sci., Phila., p. 27.

BODY small, somewhat basin-shaped, about twice as wide as high to the top of the first radials, broadly truncated, and concave below, with but slightly expanded or nearly vertical sides. Base occupying the concavity of the under side, and apparently flat or concave. Subradial pieces about as high as wide, a little convex, rising vertically, except below, where they curve abruptly inward to connect with the base; all seen, presenting pentagonal general outlines on their outer faces. First radial pieces nearly twice as wide as high, pentagonal in form, and truncated their entire breadth above for the reception of the second radials. Anal pieces unknown. Second radials longer than wide, strongly constricted in the middle, with steeply sloping sides for the support of the arms above. Arms simple from their origin on the second radials, slender, and composed of long, rounded, somewhat constricted joints, which are obliquely truncated at the ends, with the upper end of all projecting alternately on opposite sides, for the support of long, very slender tentacles, composed of long joints.

Breadth of body, near 0.30 inch; hight, 0.15 inch; arms, apparently about 1.12 inches in length, and only 0.05 inch in thickness at the constricted part of the lower joints; first four joints, 0.32 inch in length.

In its depressed body, with nearly vertical sides and broadly truncated, concave lower part, this species seems to resemble *S. unicus*, Hall, as near as can be determined from a description alone. It differs, however, in having the arms simple from their origin on the second radials, with long, instead of very short joints. It is peculiar in the broadly truncated and concave character of its under side, as well as in the slenderness of its arms and pinnulæ. The latter are also remarkably distant from each other, owing to the length of the arm joints.

Locality and position—Keokuk division of the Lower Carboniferous series; Crawfordsville, Indiana.

SCAPHIOCRINUS UNICUS, Hall.

Pl. 15, Fig. 5.

Scaphiocrinus unicus, HALL, 1861. Prelim. Descr. New Crinoidea, p. 8.

Locality and position—Keokuk group; Crawfordsville, Indiana.

SCAPHIOCRINUS ÆQUALIS, Hall.

Pl. 15, Fig. 6.

Scaphiocrinus æqualis, HALL, 1861. Prelim. Descr. New Crinoidea, p. 8.

Locality and position—Keokuk group; Crawfordsville, Indiana.

SCAPHIOCRINUS COREYI, M. and W.

Pl. 15, Fig. 1.

Scaphiocrinus Coreyi, MEEK and WORTHEN, 1869. Proceed. Acad. Nat. Sci., Phila., p. 148.

BODY of medium size, basin-shaped, or about twice as wide as high, rounded, and distinctly concave below. Base small, and nearly or quite hidden by the column in the concavity of the under side. Subradial pieces comparatively rather large, curving under to connect with the base, all presenting a general hexagonal outline, excepting two on the anal side, which are heptagonal; they must each, however, have another obscure angle below. First radial pieces about equaling in size the subradials, but proportionally wider, being sometimes slightly more than twice as wide as long, all pentagonal in form, the upper side being much the longest, and the lateral margins short. Second radials a little longer than the first, but narrower above, and more or less constricted around the middle; pentagonal in form, the upper angle being rather salient, and each supporting an arm on each of their superior sloping sides. First anal piece about one-third as large as one of the subradials, hexagonal in form, and resting between the upper sloping sides of two of the subradials, and partly under one side of one of the first radials on the right; while it supports another anal piece above, and connects with a third on the left, which rests upon the upper truncated side of one of the subradials.

Arms moderately long, carinated along the middle of the outer side, and after the first division on the second radials, dividing again on the sixth or eighth, beyond which they are all simple; each composed of alternating wedge-shaped pieces, which are a little wider than long, and each projecting on alternate sides above for the reception of tentacles, which are stout, angular, and composed of pieces nearly twice as long as wide.

Breadth of body, 0.55 inch; hight to top of first radials, about 0.20 inch.

This species is remarkable for the curious rough appearance of the arms, produced by the projection of the pieces alternately on each side, and the interruption of the carina along the dorsal side, which is not continuous, but looks as if the pieces had been slipped a little alternately to opposite sides.

Locality and position—Crawfordsville, Indiana. Keokuk division of the Lower Carboniferous series.

SCAPHIOCRINUS MCADAMSI, Worthen, Ms.

Pl. 15, Fig. 2.

BODY below a medium size, broadly cup-shaped below the top of the first radials, plates moderately thick and smooth, sutures well defined. Base small, convex, about half as high as wide, articulating facet for the column about one-third the width of the base at its upper extremity, and covered by the first joints of the column in the specimen under examination. Subradials rather small, three of them hexagonal, the two on the anal side larger and heptagonal. First radials nearly twice as large as the subradials, width greater than the hight, pentagonal and hexagonal in form. Second radials higher than wide, truncated below, concave on their lateral margins, and produced into a salient angle above. First anal plate nearly as large as the subradials, pentagonal, and above this two more small anal plates are partly visible.

Arms rather slender, one starting from each side of the second radial in the antero-lateral rays. The arms are composed of wedge-shaped pieces, the first one in each ray being about twice as long as those above.

This species is nearly allied to *S. decadactylus*, Meek and Worthen, in Vol. II, of the Ill. Geol. Survey, p. 238, Pl. 17, Fig. 3, but differs from that species in the relative size and form of the body plates, and the size and structure of the arms.

Dedicated to the Hon. WILLIAM MCADAMS, of Otterville, in Jersey county, from whom we received the typical specimen, and to whom we are indebted for many fine specimens from the same horizon in Jersey county.

Locality and position—Keokuk Limestone, Otter creek, Jersey county, Illinois.

FORBESIOCRINUS WORTHENI, Hall.

Pl. 14, Fig. 2, and Pl. 15, Fig, 7.

Forbesiocrinus Wortheni, HALL, 1858. Iowa Geol. Report, Vol. I, Part II, p. 632, Pl. XVII, Fig. 5. Supplement to same, (1860) Pl. 3, Fig. 7.

BODY attaining a moderately large size, subhemispherical in form, when the arms are broken away, but when they are attached and incurved, the whole presenting a nearly subglobose general outline.* Basal plates extremely short, or only appearing externally like a slightly thickened upper joint of the column. Subradial pieces comparatively small, four of them presenting a general subtrigonal outline, with the lateral attenuated angles slightly truncated and the upper sides sloping so as to allow the first radials to come down at the middle nearly to the base; fifth subradial much wider than the others, though scarcely as long, being about three times as wide as long, and apparently irregularly pentagonal in form. First radial pieces larger than the subradials, wider than long, and generally heptagonal in form. Second and third radials usually somewhat smaller than the first, wider than long, and hexagonal in outline. Fourth radials of near the same size as the others, pentagonal or hexagonal in form, and supporting on each of their superior sloping sides, in direct succession, three secondary radials of nearly the same sizes and forms as the primary radials; of these the last one of each series is an axillary piece, and bears smaller tertiary radials, a portion of which, in those having seven or more pieces, being free, and the last one in each series bearing two subdivisions, one of which is a simple free arm smaller than the other division, which latter divides again on the fifth, seventh or eighth piece, the smaller inner division being a simple arm, while the other bifurcates so as to form at least two arms farther up, thus making, as far as can be seen in the specimen, eight arms to each of the two main divisions of each ray, or eighty to the entire series. Arms all comparatively short, flat, or very nearly so, on the dorsal side, and in contact laterally all around, when folded upward.

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* Prof. HALL describes the body as being "somewhat discoid." This, however, is only the case in accidentally compressed specimens.

Interradial arms lance-ovate, or elongate sub-rhombic, and nearly or quite even with the radial series on each side; occupied each by from twenty-five to thirty pieces, commencing below with one hexagonal piece in the first range, over which are two in the second range, three in the third, three or four in the fourth, fifth, sixth and seventh, while the remaining smaller pieces are irregularly arranged in the gradually narrowing space above. Anal area wider below than the interradial areas, and like them nearly or quite even with the radial series on each side; occupied by about thirty pieces, arranged with two in the first range, and four in two or three of those above, while the narrowing space over the latter is occupied with irregularly disposed smaller pieces.

Interaxillary areas with eleven to about thirteen small pieces each, arranged in two series above the first one; interaxillary spaces, or the second order, each occupied by three or four pieces in direct succession.

Patelliform pieces intercalated between the different pieces of the radial series, well developed all the way up into the arms.

Column near the base very thick, round, and, as usual in the group, composed of very thin pieces, but tapering rapidly below.

Surface of the figured specimen eroded so as not to show the granules usually seen on the species.

This is one of the few species of all those that have been referred, in this country, to *Forbesiocrinus*, that really possess the characters distinguishing that group, most of the others having either only a single range of anal pieces, like an arm, rising in the middle of the anal area, with a kind of integument of minute pieces on each side, and thus belonging to the section *Onychocrinus*, or having one or two anals, and one or two interradials, or sometimes none, and thus belonging to the section *Taxocrinus* proper. In this species, as well as all other typical forms of *Forbesiocrinus*, the anal and interradial areas are all filled with well developed plates all the way up. We believe, however, as elsewhere stated, that these three groups form only sections of the one genus *Taxocrinus*.

The species under consideration seems to be most nearly allied to *F. multibrachiatus*, of Lyon and Casseday, (Am. Jour. Sci. and Arts, Vol. XXVIII, p. 235, 1859), but has nearly twice the number of interradial pieces to each area, and about five times as many anal pieces, as well as about twenty more arms, or divisions of its rays.

Locality and position—This species was originally described by Prof. HALL, from the Keokuk division of the Lower Carboniferous, at Keokuk, Iowa, and we have it from the same horizon at Hamilton, Hancock county, of this State. The very beautiful specimen we have figured is from rocks of the same age at Crawfordsville, Indiana, and belongs to the collection of Mr. COREY. As far as can be determined from an eroded specimen, the example we have figured agrees well with those from the Iowa and Illinois localities, excepting that its anal and interradial areas are not sunken, but nearly even with the radial series. This, however, may be in part due to the wearing away of the surface of the latter.

ONYCHOCRINUS EXCULPTUS, L. and C.

Pl 14, Fig. 4.

Onychocrinus exculptus, LYON and CASSEDAY, 1859. Amer. Jour. Sci., Vol. 29, new series, p. 78.

Locality and position—Keokuk group. The specimen here figured is from Crawfordsville, Indiana.

GENUS AGARICOCRINUS, Troost.

AGARICOCRINUS WHITFIELDI, Hall.

Pl. 12, Fig. 1 a, b. Pl. 15, Fig. 8.

Agaricocrinus Whitfieldi, HALL, 1868. Iowa Report, p. 621. Supp. same, Pl. 3, Fig. 5, 1860.

BODY attaining a rather large size, depressed subhemispherical, the vault being moderately convex, and the under side so very deeply concave, that when the body is placed upon a level surface, with the under side down, it rests upon the first brachial pieces. Basal pieces very small and entirely hidden by the column. First radials rather small, wider than long, and hexagonal in form. Second radials, except on the posterior side, slightly smaller than the first, and all quadrangular excepting one on the anal side, which has one of the upper angles (sometimes) truncated so as to make a fifth angle. Third radial plates considerably larger than the first or second, wider than long, three of them hexagonal, one pentagonal, and one with a general hexagonal form, but one of the upper angles sometimes truncated, so as to make a seventh angle.* First brachial pieces very large, of different forms; second generally very wide and short, and upon these, and in part upon the first, the arms commence. First interradial plate more or less elongated, and irregularly octagonal or heptagonal in form, and supporting in the next range two very narrow, much elongated pieces extending up between the arms so as to connect with the vault. First anal plate slightly longer than the first subradials, and supporting on its short upper truncated side an elongated hexagonal piece; while its superior lateral sloping sides each supports a somewhat larger, elongated octagonal plate, which like the middle piece extends up and connects with another range of five smaller pieces, reaching the vault.

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*Prof. HALL describes these plates as being two hexagonal, and three pentagonal; this, however, is certainly an error, as we know from the typical specimen now before us. His *diagram*, however, represents their form correctly.

Dome composed of numerous plates of various forms and sizes, most of which, however, are small, and all are nearly or quite flat, excepting one large convex piece immediately over the axil of each ray. A few of those in the central region are also larger than the others, but not distinctly convex. Opening small, and situated about half way between the middle of the vault and the anal side; surrounded by small plates, which are not protuberant.

Surface of body plates finely and beautifully granulo-striate—the striæ showing a tendency to radiate from the central region towards the sides of the plates.

Hight of body and dome, 0.90 inch; greatest breadth, measuring across between the prominent arm-bases, 1.40 in.

This species is about of the same size as *A. Americanus* of Roemer, (*A. Tuberosus*, Troost ?,) but will be at once distinguished from that form by its more depressed body, much smaller and flat dome pieces, and its flattened instead of protuberant anal region.

Locality and position—Greene county, Illinois; from the Keokuk division of the Lower Carboniferous series.

GENUS DICHOCRINUS, Munster.

DICHOCRINUS EXPANSUS, M. and W.

Pl. 14, Fig. 1.

Dichocrinus expansus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1868, p. 341

BODY expanding rather rapidly from the facet for the attachment of the column to the top of the base, and still more rapidly from there to the top of the first radials, so as to make the breadth at the latter point about twice the hight. Base forming less than half the hight of the body, somewhat basin-shaped, though narrow below, and ornamented with small, irregular, wart-like nodes, which show some tendency to form three or four vertical rows or ridges on each basal piece. First radial pieces comparatively large, somewhat oblong in form, being longer than wide, with the widest end above, all convex along up the middle, and strongly beveled or excavated along the sutures on each side, while the surface of each is ornamented with small, irregular, wart-like nodes, similar to those on the base; these sometimes coalesce into irregular ridges, but are usually arranged in three rows, starting from the most prominent upper end of the plates, and radiating to the base; facet for the reception of the second radial pieces about one-third the breadth of the upper end of the plates, and somewhat excavated. Anal piece of much the same size and general nodose appearance as the first radial on each side, but somewhat longer, and having an irregular hexagonal form. Second radial pieces small, about twice as wide as long, and more or less quadrangular in form. Third radials slightly larger than the second, with a pentagonal form, the upper sloping sides supporting the first division of the arms. Arms rounded, composed at first of pieces about as long as wide, upon the second or third of which they bifurcate, the outer divisions remaining simple, and the inner ones bifurcating again on the second or third piece, the outer division, as before, remaining simple, and the inner bifurcating a third time on the second pieces, thus making in the posterior rays (the only ones seen) eight arms to each ray, or forty in the whole series, if other rays have the same number. All the simple arms are long, slender, rounded, and but slightly tapering; near their bases they are each composed of a single series of somewhat wedge-formed pieces, but gradually pass into a double series of minute interlocking pieces.

Breadth of body, 0.98 inch; hight, about 0.43 inch; length of one of the simple arms, about 1.60 inches; thickness of same at base, 0.05 inch.

Associated with the specimen from which the foregoing description was drawn up, several other imperfect examples were found, differing more or less in form and in the arrangement of their ornamentation, which either indicate considerable variations in these characters, or the existence of several allied species. One of these has the first radial and anal plates more abruptly spreading, and proportionally wider than in the typical form, while its nodes are more coalescent, so as more generally to run into continuous ribs. On the base, for instance, each of the two plates has three somewhat nodulous, vertical ridges, with intervening rows of the little nodes, while the three rows of nodes on the first radial and anal pieces often run together so as to form mere nodulous ridges. It is possible this would be found to be a distinct species, if we could examine a specimen showing the arms. If so, it may be called *D. stelliformis*, in allusion to the star-like appearance produced by its spreading first radial pieces, with their little ridges running outward and converging to the outer extremity of each.

In another individual the nodes and ridges are all nearly obsolete, excepting a few of the former, which are very prominent at the middle of the outer ends of the first radials; while another has a single prominent node near the small facet in each first radial, for the reception of the second, with a few irregularly scattering nodes on other parts, and slender, obscure, nodular ridges near the lateral margins. From the general appearance of these specimens, we are rather inclined to the opinion that they are all varieties of one variable species.

Locality and position—Keokuk division of Lower Carboniferous series; Crawfordsville, Indiana.

DICHOCRINUS FICUS, C. and L.

Pl. 14, Fig. 5.

Dichocrinus ficus, CASSEDAY and LYON, 1860. Proceed. Am. Acad. Arts and Sci., Vol. V, p. 24.

Locality and position—Keokuk group; Crawfordsville, Indiana.

GENUS CALCEOCRINUS, Hall.

CALCEOCRINUS? BRADLEYI, Meek and Worthen.

Pl. 14, Fig. 9.

Calceocrinus Bradleyi, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 73.

BODY, exclusive of the base, subquadrangular, with the upper lateral angles obliquely truncated, and the sides rather deeply sinuous, or constricted above the middle; compressed antero-posteriorly, and rather distinctly concave in the central region of the dorsal side below the middle. Lower dorsal plate triangular, and more than twice as wide as high. Dorso-lateral pieces twice as high as wide, presenting an irregular pentagonal outline, with sloping sides above diverging at an angle of about 90 degs. Upper dorsal plate about half the size of the lower, subtriangular, or nearly semicircular, slightly more than half as long as wide, and scarcely more than filling the notch between the inner sloping sides of the dorso-lateral pieces. Dorsal arm slender, rounded, and composed first of five pieces, the lower of which is expanded below so as to be nearly three-fourths as large as the upper dorsal piece, while the succeeding pieces are narrow, and slightly longer than wide, excepting the fifth one, which is a little wider than the others, pentagonal in form, and supports upon its superior sloping sides two equal divisions, which are slender, rounded, simple, and composed of pieces about twice as long as wide. Lateral divisions of the rays (or perhaps, more properly, supports of lateral arms,) composed of pieces that are wider than long, and rapidly diminishing in size from the first to the terminal one; of these, three can be counted on one side, but there may have been one or two more; each supporting an erect arm, more slender than the dorsal one, and dividing first on the third piece, the inner division being smaller than the other and remaining simple, while the larger one bifurcates again on the fourth piece, the subdivisions being equal, and of the same size as the inner branch at the first bifurcation. All the axillary pieces are expanded and more protuberant at the upper end than any of the others, though all of the other pieces are slightly projecting at the upper end. (Ventral side unknown.) Column comparatively rather stout, or slightly thicker than the dorsal arm below its bifurcation; composed, two or three inches from the body, of round, nearly equal, moderately thick pieces, but near the body showing a slight tendency to become pentagonal, and apparently composed of more irregular, somewhat roughened pieces. Surface rather distinctly granular, particularly on the dorsal side.

Length of body, exclusive of the basal pieces, 0.48 inch; breadth, 0.47 inch; length of dorsal arm to the first bifurcation, 0.62 inch; entire length, about 1.80 inch; breadth of do. near the middle, 0.10 inch; length of upper dorsal plate, 0.15 inch; breadth of do., 0.20 inch.

Compared with Prof. HALL'S figure of the body of his *C. tunicatus*, and with specimens we have identified with that species, this form differs in having the body not narrowing upward, being as wide across just above the constriction as at the base of the dorso-lateral pieces; the constriction of the sides is also distinctly above, instead of at the middle, while the outer sloping sides of its dorso-lateral pieces are proportionally shorter, and directed more obliquely outward. Its dorsal side, instead of being "flattened," is also distinctly concave below the middle. Again, its upper dorsal plate is proportionally smaller, being considerably less, instead of more than half the breadth of the body above the middle, and only just large enough to fill the depression in which it rests without projecting above, while its lower sloping margins are rounded so as to give it a semicircular outline, instead of being straight.

Compared with *C. nodosus*, Hall, the only other described species from this horizon, it will be at once distinguished by the nodose character of the latter. It likewise differs, in the details of its structure, from the various other species described by Prof. HALL from other horizons.

The specific name is given in honor of Prof. FRANK H. BRADLEY, of Hanover College, late of the Illinois Geological survey, who discovered the typical specimen, and numerous other fossils at the same locality.

Locality and position—Crawfordsville, Indiana; Keokuk division of the Lower Carboniferous series.

GENUS CATILLOCRINUS, Troost.

CATILLOCRINUS BRADLEYI, M. and W.

Pl. 14, Fig. 10.

Catillocrinus Bradleyi, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1868, p. 342.

BODY small, basin-shaped, or rather broadly truncated below for connection with the column, and moderately expanding upward to the top of the radials supporting the arms. Lower series of plates visible around the top of the column, anchylosed together, and presenting the form of a broad low dish, many times wider than high, with the margins sinuous above for the reception of the next range of pieces. Succeeding range of plates presenting the usual irregular form of the genus, two of them being much larger than the others, very wide at the top, and supporting nearly or quite all of the arms; between these on one side there is a much smaller triangular piece on the same range, and extending up as high as the others, but so narrow at the top that it could not have supported more than one or two, if any, of the small arms. On the opposite side there are two other small intercalated pieces, the smaller of which is triangular and scarcely extends up to the top of the cup, while the other is oblong, extends to the top of the cup, and supports either another somewhat smaller (anal ?) piece above, or the base of an arm much larger than the others. Arms about 44, in contact at their bases, and all slender, and composed of joints two or three times as long as wide. Surface smooth. Column comparatively very large (circular?), with a large round central canal, and composed near the base of rather thin pieces of uniform size.

Hight of body, 0.18 inch; breadth at top, 0.24 inch; breadth of column at the base of the body, 0.13 inch.

This species will be at once distinguished from *C. Tennesseeæ*, of Troost, by its much smaller size, and smooth instead of coarsely granular plates. It is much more nearly allied to our *C. Wachsmuthi*, from the Burlington group, but its body is less expanded at the top, and it also differs in having a comparatively large anal ? piece, or larger arm, between the others on one side. Named in honor of Prof. FRANK H. BRADLEY, of Hanover College, late of the Illinois Geological Survey, who discovered the only specimen known.

Locality and position—Crawfordsville, Indiana; Keokuk division of Lower Carboniferous series.

GENUS PLATYCRINITES.

PLATYCRINITES HEMISPHERICUS, M. and W.

Pl. 16, Fig. 6 a, b, c.

Platycrinus hemisphericus, MEEK and WORTHEN, 1865. Proceed. Acad. Nat. Sci., Phila., p. 162; also Geol. Survey of Ill., Vol. 3, p. 511, Pl. 20, Fig. 2 a, b.

Locality and position.—Keokuk division of the Lower Carboniferous, Crawfordsville, Indiana.

GENUS PENTREMITES.

PENTREMITES WORTHENI, Hall?

Pl. 14, Fig. 11.

Pentremites Wortheni, HALL, 1858. Geol. Surv. of Iowa, p 606, Pl. 15, Fig. 1

Locality and position—Keokuk group; Crawfordsville, Indiana.

PENREMITES (TROOSTOCRINUS?) WOODMANI, M. and W.

Pl. 16, Fig. 4.

Pentremites (Troostocrinus) Woodmani, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila, 1868, p. 356.

BODY attaining a large size, pyramidal-subovate, as seen in the side view, being broad below, and produced and gradually narrowing upward; strongly pentagonal as seen from above and below, in consequence of the projecting and actually carinated character of the radial pieces. Base strong, from two and a half to three times as wide as high, tribolate in general outline below, and very broadly and profoundly excavated along the three sutures (the excavations being continued out beyond the base into the lower ends of three of the radial pieces); two of them pentagonal and tricarinate, and one quadrangular and bicarinate, the carinæ projecting considerably below the deeply sunken facet for the attachment of the column, so that when placed erect on a level surface the body stands upon these carinæ, like a tripod upon its legs. Radial pieces long and narrow, or about three times as long as wide, and gradually tapering upward; all extremely prominent along the middle, and sloping strongly inwards laterally, very sharply carinate below the pseudo-ambulacral areas. Summit openings very small and closely approximated. Interradials very small, or only about one-tenth as long as the radials. Pseudo-ambulacral areas remarkably narrow or sublinear, and deeply sunken, extending down rather more than half the entire length of the body, or about two-thirds the length of the radial pieces; pore pieces minute, slightly oblique, and numbering about one hundred to each side of each area, the two rows of each area being separated by a deep mesial furrow, along which the inner ends of the pore pieces are minutely crenate; lanceolate and supplementary pore pieces unknown. Surface marked with microscopic lines, as fine, regular and crowded as if made by an engraver's ruling machine.

Hight, 2.25 inches; breadth, 1.64 inches; breadth of base, 1.14 inches; hight of do., 0.50 inch; depth of excavations along the sutures of base, 0.20 inch; breadth of do., from 0.45 to 0.56 inch; length of pseudo-ambulacral areas, 1.45 inch; breadth of do., 0.08 inch.

This extraordinary form differs so widely from all other known species, as to render a comparison of its specific characters with any of those hitherto described entirely unnecessary. It seems to be related to a group of species characterized by a triangular base, and very narrow pseudo-ambulacral areas, for which Dr. SHUMARD has proposed the name *Troostocrinus*. Still it presents some rather strongly marked differences from that group, the species of which have the body narrow, fusiform, and more or less elongate and tapering below, with the triangular base merely flattened on each of the three sides. In our type, however, the body is broadest below, while the base is comparatively very short and wide, and has the three spaces corresponding to the flattened sides of the typical species of *Troostocrinus* so very profoundly and broadly excavated, as to impart a very remarkable appearance to the lower part of the fossil. Should it be thought desirable to designate this type by a distinct subgeneric name, it might be called *Tricœlocrinus*, in allusion to the three deep excavations of the base.

The specific name of this form is given in honor of Mr. H. T. WOODMAN, of Dubuque, Iowa, to whom we are indebted for the use of the only specimen we have seen.

Locality and position—Salem, Indiana; Lower Carboniferous, Keokuk group ?

GENUS GRANATOCRINUS.

GRANATOCRINUS GRANULOSUS, M. and W.

Pl. 15, Fig. 10.

Pentremites (Granatocrinus) granulosus, MEEK and WORTHEN. Proceed. Acad Nat. Sci., Phila., 1865, p. 165.

BODY small, subglobose, base deeply concave, particularly in the middle, and not visible in a side view. Radial plates a little longer than wide, about two-thirds as long as the entire body, and tapering from above to the base, each divided by the narrow, pseudo-ambulacral areas, down almost to the very base; lateral margins moderately prominent. Interradial pieces subtrigonal, or with a fourth obscure angle in the middle below; longer than wide, and each narrowing from below to the summit, where they are perforated by two minute openings. Anal piece of the same size and form as the interradial, with its opening circular, and comparatively large, its outer margin being protected by a small, rather pointed node. Pseudo-ambulacral areas narrow, or sublinear, rather impressed, and each with a distinct longitudinal, linear, mesial furrow; pore pieces from twenty-five to thirty. Surface marked by comparatively distinct granules, most strongly defined on the interradial and anal pieces, where they sometimes show a tendency to arrange themselves in transverse lines parallel to the lower margin.

Hight of body, 0.22 inch; breadth of do., 0.23 inch; breadth of pseudo-ambulacral areas, 0.05 inch.

Not having at hand a specimen or figure of the type of TROOST'S *Granatocrinus*, we are not quite sure this form belongs to that group, though we have no doubt in regard to the propriety of separating such species from the typical forms of *Pentremites*. Our species has somewhat the general form and appearance of *P. Rœmeri* of Shumard (Missouri Rep., pl. *b*, figs. 2 *a*, 2 *b*, 2 *c*, 2 *d*,) but differs too widely to render a detailed comparison necessary.

Locality and position—Keokuk division of Subcarboniferous series; near Warsaw, Illinois.

GENUS PROTASTER, Forbes.

PROTASTER? GREGARIUS, M. and W.

Pl. 16, Fig. 5.

Protaster gregarius, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 169.

THE disc of this species is circular in outline, slightly convex above, and measures from 0.20 to 0.30 inch in diameter. In most cases it looks as if merely covered by a smooth, membranaceous integument. Some casts of its external surface, however, seem to show traces of flat, nearly smooth, imbricating scales above. The five arms are slender, flexible, and rather long in proportion to breadth. In a specimen with a disc measuring 0.25 inch in breadth, the diameter of the arms near the disc is only 0.05 inch. None of the specimens show the entire length of the arms, though some fragments of them were seen lying detached in the matrix, about 0.55 inch in length, without being complete at either end. From the breadth and gradual taper of these, it would seem probable that when entire they may have been 0.75 to 1 inch in length. Their impressions in the matrix give no indications of a longitudinal furrow along the under side, but show that there were about six pairs of arm pieces in a length of 0.16 inch. These pieces appear to be nearly though not exactly opposite, and each one provided below with a comparatively large, round, deep pit, or pore, near the middle of its anterior side. Along their lateral margins there appear to be impressions in the matrix of very small spines (one to each arm piece), though if such, they must have been extremely short. Impressions of the upper side of the slender arms show them to have been somewhat rounded above, with the nearly square arm pieces slightly alternating. Some of the impressions seem to show traces of central pores or pits, one at the middle of each pair of pieces, though in others no traces of these are visible.

We have numerous specimens of this little species before us, but as they are all merely in the condition of casts and moulds, in a very fine, somewhat granular matrix, they do not show the details of its structure very clearly. As far as its structure can be made out, however, it seems to agree well with the general features of the genus *Protaster*, as illustrated by Prof. HALL, in the Twentieth Report of the Regents of the University of N. Y. on the State Cabinet of Nat. Hist., though not with Mr. SALTER'S figures of *P. Miltoni.* It will probably be found to be generically distinct from the Silurian typical forms of *Protaster*, but we prefer to place it provisionally in that genus for the present. We are not aware that any well defined species of the genus *Protaster*, however, have been found in Carboniferous rocks.

Locality and position—Crawfordsville, Indiana. Keokuk division of the Lower Carboniferous series.

Genus ONYCHASTER, M. and W.

Onychaster Flexilis, M. and W.

Pl. 16, Fig. 3.

Geol. Surv. of Illinois, Vol. III, p. 526. Proceed. Acad. Nat. Sci., Phila., 1869, p. 83.

Genus PHOLIDOCIDARIS, M. and W.

Pholidocidaris, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 77.

Entire form unknown. Interambulacral plates rather thin, very irregular in size and form, all strongly imbricating apparently from below, and toward the lateral margins of the areas; arranged in five or more rows, only the outer two of which seem to be continued to the extremities of the areas; all occupied with generally obscure secondary granules, and most of those on the lower (?) side of the body, also provided with large primary central tubercles and spines; primary tubercles sometimes showing a small pit in the top, surrounded by two smooth rings, separated by an annular furrow, and all without any ring, depression or prominence around the base; on the upper (?) side of the body only the marginal rows provided with primary tubercles. Ambulacral areas wide, and occupied by six or more irregular rows of unequal, irregular pieces, some of which are as large as the smaller interambulacral plates, and all strongly imbricating in the opposite direction from the interambulacral series; each pierced by two pores, and the larger ones usually marked with one or two additional pits, which, with the pores, are surrounded by a large circular impression, while some of them sometimes show a tubercle intermediate in size between the primary and secondary series. Apical disc unknown, but a single rather large plate, believed to belong to it, is seen to have six or seven pores circling around near its outer margin, and a small tubercle in the middle.

This type is related to several of the other palæozoic genera, but cannot be properly referred to any of them. In the great irregularity of its interambulacral plates, both in size and form, as well as in the absence of primary spines, excepting on the marginal rows, (at least on the upper (?) side of the body), it seems to be very similar to *Perischodomus*, of McCoy. It differs, however, clearly from that group in the much greater breadth of its ambulacral areas, the greater number of ranges of ambulacral pieces, and their greater irregularity, as well as in the much larger sizes of some of them, and their peculiar circular impression around the two pores. If *Perischodomus* has its plates not imbricating, that would also be another important difference; but although that character is not mentioned in the description, we suspect it may really exist, because we find it to occur in all the analogous types in this country.

From *Lepidechinus* it is also readily distinguished by the much greater breadth of its ambulacral areas, and its more numerous rows of ambulacral pieces and pores, as well as by the larger size and the other peculiarities of these species.

In the breadth of its ambulacral areas, and the number of rows of pieces occupying the same, it is more nearly related to our *Lepidesthes*, but it differs in the great irregularity of these pieces, both in size and form, as well as in the curious circular impressions of the same; also in the possession of large primary tubercles and spines on some of the interambulacral pieces.

It is probably more nearly related to the form referred in this paper, doubtfully, to *Eocidaris*, but it differs materially in the much greater breadth of its ambulacral areas, more numerous ranges of ambulacral plates, and the larger sizes, and other peculiarities of these species, as well as in not having primary spines and tubercles on all of its interambulacral plates.

PHOLIDOCIDARIS IRREGULARIS, M. and W.

Pl. 15, Fig. 9.

Pholidocidaris irregularis, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 78.

The specimens of this fossil that we have had an opportunity to study are too much crushed and broken to give a clear idea of its general form, or to admit of being systematically described. It seems to have attained a rather large size, however, and if of a depressed subglobose form, may even have measured as much as three and a-half to four inches in its transverse diameter. Some specimens show from five to six ranges of interambulacral plates lying together, so as to indicate that there were at least that many ranges between ambulacra at that point. These six ranges, as they lie flattened by pressure, measure about two inches across.

All of these interambulacral plates are thin and sharp at the edges, and of only moderate thickness in the central region, while they present such a variety of forms that it would scarcely be possible to give a correct idea of their outlines, without describing each individual plate. They are generally a little longer than wide, however, and on what appears to be a part of the body below the middle, most of them have the primary tubercles more or less distinctly developed, though on some they are obsolete, or not easily distinguished from the obscure secondary ones.

On what appears to be the upper side of the body, no traces of any but the small secondary tubercles covering the surface of all of these plates are visible, excepting, as already stated, on those of the marginal rows. These marginal plates on this side are generally each as large as three or four of those adjoining them, and in some instances measure 1 inch in length, and about 0.60 inch in breadth, being of an elliptic form. The primary tubercle of each is placed about midway of the length, and between the middle and the ambulacral side. In many instances these tubercles are rounded off, as if the spines had been dropped during the life of the animal, and the tubercles partly absorbed away.

The ambulacral plates are apparently even more irregular in size and form than those of the interambulacral series. In one crushed specimen, showing a part of the fossil composing apparently the under side, extending an inch or more away from the supposed oral opening, portions of three of the ambulacral and two of the interambulacral series of plates are seen, apparently nearly in their relative positions, excepting that they are all spread almost on a plane, and more or less displaced and broken by accidental pressure. Here, near the ends of the areas, there are apparently only two rows of interambulacral plates in each series, the two ranges measuring together only about 0.40 inch in breadth; soon, however, they pass into three or four ranges. The ambulacral areas, at about one inch from the apparent position of the oral orifice, measure nearly an inch in breadth, and, as near as can be counted, there appear to be there six or more ranges of ambulacral plates. These plates appear to increase in size and decrease in number toward the end of the areas, so that some of them are there nearly as large as the adjacent interambulacral plates. They are generally wider than long, and as they lie together present more or less rhombic faces, arranged somewhat like the scars on the surface of some species of *Lepidodendron.* This similarity is also increased by the pores, and some little pits in the central region, surrounded by the circular depression. Some of the larger of these plates have the pores near one end, and a tubercle occupying the middle, nearly as large as the primary tubercles on the adjacent interradials. These probably belong to the middle ranges.

The larger primary spines attained a length of about one inch, and a thickness of 0.10 inch at the head, which is a little swollen; above this they taper rather gradually, are rounded, nearly straight, and marked by minute, crowded, longitudinal striæ. Among the ambulacral plates there are also seen lying scattered about a number of other spines, from one-fourth to one-third the size of those described, and of very nearly the same form. These seem to belong to the ambulacral plates, on most of which we see a tubercle larger than the secondary tubercles of the interambulacral plates. Many much smaller spines than the latter are likewise seen, that probably belong to the secondary, or perhaps, more properly, tertiary series.

Locality and position—Hamilton, and near Nauvoo, Illinois; in the Keokuk division of the Lower Carboniferous series.

GENUS AGELACRINITES, Vanuxem.

AGELACRINITES (LEPIDODISCUS) SQUAMOSUS, M. and W.

Pl. 16, Fig 1.

Agelacrinites (Lepidodiscus) squamosus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1868, p. 357.

DEPRESSED discoidal, outline circular, or somewhat oval. Rays slender, long, and strongly curved as they radiate from the middle toward the periphery, around which they are each extended for some little distance; all sinistral, excepting the right posterior one, which curves to the left, with its outer half extending around within that of the next one on the left, near which it terminates at the so-called ovarian protuberance; each composed of two zigzag rows of very small pieces, with some irregular ones apparently not belonging properly to either row. Disc composed of large, thin, irregular, strongly squamose or imbricating plates, the imbrication being inward from the periphery, that is, the inner edge of each plate laps upon the outer edge of the next within. Ovarian? pyramid situated near the left outer margin of the posterior interbrachial space, and closed by ten pieces, apparently imbricating laterally, and forming a depressed cone, around the base of which there are numerous small, short, but comparatively wide imbricating disc plates. Surface minutely granular.

Greater diameter of an apparently distorted specimen, 1.70 inches.

The only specimen of this species we have seen is somewhat crushed and distorted, so that it is rather difficult to make out the exact details of the structure of the rays, though they are apparently not provided with *open* ambulacral furrows, the rows of minute plates on each side, apparently closing up and interlocking. There appear, however, to be pores arranged along them in a zigzag row between the pieces. The body plates around the margin are much wider than high, and strongly imbricating upward. No central opening is visible.

On comparing this species with *A. Kaskaskiensis*, Hall, (the only other known Carboniferous species,) the type of which is now before us, we find that our species differs in the important character of having its disc plates all very distinctly imbricating, while those of Prof. HALL's species show no tendency to imbricate, the whole surface of each being clearly exposed, their straight edges being merely joined together like those of a true crinoid. From Prof. HALL's description, it might also be supposed that this species differs in the number of its rays, as he described it as having six rays. A careful examination, however, of the typical specimen has clearly satisfied us that this is certainly not the case, as it has only five, the usual number, as represented in the figure. It is the incurved extremity of the dextral right posterior ray that has been mistaken for a sixth ray. The specimen is somewhat crushed and distorted, but by carefully cleaning it and removing some adhering portions of the matrix, this ray can be traced straight out to the periphery, where it curves abruptly around and extends inward to near the middle of the posterior interbrachial space, where it terminates at a point near which was doubtless situated the so-called ovarian pyramid, though the specimen is too much crushed there to show the latter.

It is worthy of note that our species, although agreeing with most of these that have been referredto *Agelacrinites*,* in the imbricating character of its disc plates, as well as in the direction of the curvature of its rays, still differs from *A. Hamiltonensis*, of Vanuxem, the type of the genus in both of these characters. VANUXEM gives no description, but, judging from his figure, (Geol. Report, Third District, N. Y., p. 306,) one would naturally suppose the disc plates of his species to have the usual imbricating arrangement. Prof. HALL, however, has recently described it in detail, (Twentieth Report Regents Univ., N. Y., on State Cab. Nat. Hist., p. 299, 1868,) and distinctly states that its interbrachial or disc plates are not imbricating, as in other species. He also mentions the fact that this typical species differs from others in having its anterior and right anterior and posterior lateral rays sinistral, and its left anterior and posterior-lateral rays curved to the left, as shown in VANUXEM'S figure. It therefore certainly seems to us doubtful whether species differing in two such important characters as these are strictly congeneric. If they are not, then a new generic name should be applied to our species, and the others agreeing with it in these characters, in which case we would propose to designate this group of species under the name *Lepidodiscus* (γεπίς, a scale, and δίσχος, a quoit.) At least we should think they ought to be separated suogenerically.

Locality and position—Crawfordsville, Indiana. Keokuk beds of Lower Carboniferous.

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* By some oversight, Prof. PICTET figures, on pl. xcix, fig. 25, of his valuable Trait de Palæont., a true *Agelacrinites*, and probably one of the Cincinnati species, under the name *Hemicistites parasitica*, Hall, a very different fossil from the Niagara group. He also alludes to Vanuxem's *Agelacrinites Hamiltonensis* in the text as a Silurian species, but it is a Hamilton group (Devonian) fossil. Dujardin and Hupe (Hist. Nat. Echinod., pl. 5, fig. 8), copy PICTET'S figure under the name *Agelacrinites parasitica*, as an illustration of *Agelacrinites*, saying *Hemicystites* ought not to be separated from *Agelacrinites*. The real *Hemicystites parasitica*, however, although related to *Agelacrinites*, differs in several important characters.

MOLLUSCA.

GASTEROPODA.

GENUS PLATYCERAS, Conrad.

PLATYCERAS UNCUM, M. and W.

Pl. 17, Fig. 1.

Platyceras uncum, MEEK and WORTHEN, 1866. Proceed. Acad. Nat. Sci., Phila., p. 264.

SHELL under medium size, in adult examples elongate-conical and oblique; body portion nearly straight, especially on the posterior side; apex attenuate, pointed, laterally compressed and curved backwards (without any lateral obliquity) so as to form a free hook of about half a turn. Aperture generally a little wider transversely than the antero-posterior diameter, and usually showing a faintly subangular outline, produced by the prominence of the front and the flattening of the posterior side of the body. Lip irregularly undulated, prominent on each side, broadly sinuous behind, and provided with a very deep, narrow sinus. Surface with the usual undulating lines of growth, crossed on the lower half of the body by small, rather obscure, longitudinal plications, and in front by a larger but narrow, prominent ridge, upon which the lines of growth make a strong curve, indicating the presence of the anterior sinus during most of the growth of the shell.

Length, 1 inch; breadth (transverse diameter of the aperture,) 0.70 inch; antero-posterior diameter of the aperture, 0.55 inch.

This species is intermediate in size, as well as in some other respects, between *Platyceras acutirostris* (= *Capulus acutirostris*, Hall, and *P. æquilatera*, Hall.) In size and general appearance, it agrees most nearly with the former, though it is larger and differs in having its apex merely hooked instead of subspiral, as well as in its prominent anterior ridge and deeper and narrower anterior sinus. From *P. æquilatera*, it is distinguished by its smaller size, narrower and straighter form (particularly at maturity), less incurved beak, prominent anterior ridge, deeper anterior sinus, and proportionally less expanded aperture. It also wants the anterior lateral sinuses of the lip seen in that species.

It is quite evident that the sinuosities of the lip in shells of this genus, although, as elsewhere suggested, to a considerable extent modified by the inequalities of the surfaces to which the animal had attached itself, still generally show some *tendency* to regularity in different individuals of the same species, especially in those usually with one or more deep sinuses.

Locality and position.—Keokuk limestone of the Lower Carboniferous series, at Nauvoo, Illinois.

PLATYCERAS INFUNDIBULUM, M. and W.

Pl. 17, Fig. 3.

Platyceras subrectum, HALL, 1860. Supp. Iowa Report, p 1, (not *P. subrectum*, Hall, 1859.) Twelfth Ann. Rep. Regents' Univ., N. Y., on State Cab., N. H., p. 18.

Platyceras (Orthonychia) infundibulum, MEEK and WORTHEN, 1866. Proceed. Acad. Nat. Sci., Phila., p. 266.

SHELL straight, more or less elongate-conical, very slightly oblique, somewhat attenuate near the straight, sub-central apex, thence expanding at first rather gradually and then more rapidly to the regularly sub-circular, sub-quadrate, or more or less oval aperture; lip rather thin and irregularly undulated, as if to correspond to an uneven surface of attachment. Surface with more or less distinct, undulating, concentric striæ, and near the lip stronger marks or laminæ of growth; also generally provided with a few large, obscure, irregular, undefined longitudinal folds.

Length, 1.40 inch; breadth, about 1.30 inch.

As remarked by Prof. HALL, this species varies considerably in the degree of expansion, some specimens being much more attenuated than others. It is possible that in very young individuals, the minute immediate apex may have been curved or sub-spiral, but in all those we have seen it is straight, and sometimes a little compressed, and only removed from the central position by the slight general obliquity of the whole shell, without any curve. In some of its forms it resembles *P. Quincyensis*, of McChesney, from the Burlington division of the Lower Carboniferous, though it differs, even when, as is sometimes the case, it is nearly as strongly plicated as that shell in its more regular, less attenuate form and rougher surface, as well as in not having its folds or plications forming five regular, broad ridges more or less flattened and concave along their middle.

From *P. fissurella*, Hall, this species differs in being less depressed, or more attenuate, particularly near the apex, which is never oblique, as in that species.

Prof. HALL had described this species in 1860, but as he, by an oversight, gave it the same specific name *(subrectum)* he had previously applied to another species from the Upper Helderberg rocks of New York, it became necessary, in order to prevent confusion, that our Illinois shell should receive another name, and hence we proposed to call it *P. infundibulum*.

From the same locality and position with the above, we have a single specimen, differing from the others in being greatly more slender and elongated. It is perfectly straight, somewhat compressed laterally, and about twice as long as wide, being very attenuate above the middle, and but moderately expanded below. It is an internal cast, showing no surface markings, but preserving the transversely elongate-oval muscular scar on each side, apparently connected by a slender band passing around behind. Without more specimens, it is not possible to determine beyond doubt whether this is a distinct species, or only an elongate varity of the *P. infundibulum*. Should it prove to be distinct, we have proposed, in the paper cited at the head of this description, to call it *P. (Orthonychia) extinctor*, from its resemblance in form to a candle extinguisher. It is represented by figures 3, *d*, *e*, of plate 17.

Locality and position.—Keokuk division of the Lower Carboniferous series, at Warsaw, Illinois.

PLATYCERAS EQUILATERA, Hall.

Pl. 17 Fig. 2.

Platyceras equilatera. HALL, 1860. Supplementary sheet to Vol. I, Part II, Iowa Report, p. 1.

SHELL attaining a medium size, composed of about one to one and a half turns; appex small, laterally compressed, and closely incurved, nearly on the same plane as the general curve of the body of the shell, or but very slightly oblique; body portion merely arched, and rapidly and nearly equally expanding to the aperture, which has an irregular, sub-circular, or broad sub-oval, outline; lip rather sharp, and more or less sinuous, sometimes distinctly so. Surface with undulating lines, and near the margins of the lip, stronger sub-imbricating marks of growth; the undulations in the markings corresponding to the sinuosities of the lip, which sometimes produce traces of obscure longitudinal folds near the aperture.

Greatest length of a mature specimen, measuring from the anterior margins of the lip to the most prominent part of the arch of the spire, 1.62 inches; breadth of the aperture, 1.15 inches.

Like many other species of this genus, this shell varied considerably at different stages of growth, the young shells being nearly smooth, while in adults the undulating marks of growth are strongly defined near the lip, which often becomes strongly sinuous, particularly on the anterior lateral margins. In one specimen (fig. 2 *c*, pl. 17,) there are two deep anterior sinuses, with a prominent linguiform extension between. This individual has much the appearance of *P. trilobum* (=*Pileopsis trilobus*, Phillips,) to which the species is evidently closely allied.

Locality and position—Keokuk division of the Lower Carboniferous series; Keokuk, Iowa, and Warsaw, Illinois.

PATYCERAS FISSURELLA, Hall.

Pl. 17, Fig. 4.

Platyceras fissurella, HALL, 1860. Sheets entitled "Supplement Geol. Report Iowa, Vol. I, Part II, p. 2, 1859."

SHELL rather thick, obliquely depressed conical, expanding very rapidly from the apex to the base; posterior side short, the descent from the apex being steep, or sometimes nearly vertical, and concave in outline; lateral slopes straighter; anterior slope longest, and generally convex in outline; apex arching backwards a little, but showing no tendency to a spiral curve, somewhat obtusely pointed, and placed between the middle and the posterior side, or sometimes nearly over the latter; aperture very large, sub-circular or a little oval, the length being generally somewhat greater than the breadth; lip beveled and a little uneven but without distinct, regular sinuosities, excepting sometimes obscure ones around the front. Surface more or less roughened by undulating striæ, and strongly defined ridges of growth, with sometimes obscure traces of a few radiating costæ near the anterior margin.*

Hight to summit of apex, 0.96 inch; antero-posterior diameter, 1.63 inches; transverse do., 1.50 inches; (these latter being also the dimensions of the aperture.)

We have intentionally omitted to mention, in the description, the opening near the apex of this shell, mentioned by Prof. HALL, because, with the original typical specimen now before us, we feel quite confident that the opening described by Prof. HALL is an accidental break in the shell, and not a natural perforation.

The reasons for this conclusion are: first, the appearance of the opening itself; second, the fact that it does not exist in other specimens agreeing in their specific characters, from the same locality and position; and third, the fact that it is against all analogy for a shell of this genus or family to have a natural perforation at the apex, such as we see in the *Fissurellida*.

Locality and position—Warsaw, and Nauvoo, Illinois; from the Keokuk division of the Lower Carboniferous series.

PTEROPODA.

GENUS CONULARIA.

CONULARIA SUBCARBONARIA, M. and W.

Pl. 19, Fig. 4.

Conularia carbonaria, MEEK and WORTHEN, 1865. Proceed. Acad. Nat. Sci., Phila., p. 253.
Comp. *C. Verneuilii*, Emmons, 18—. Manual Geol., Sec. Ed, p. 159, fig. 7.

SHELL attaining a large size, very thin, more or less distinctly and nearly equally four-sided, the sides and angles being somewhat rounded, and converging towards the smaller extremity, at an angle of about 18°; section quadrangular mesial furrow of each side very obscure, those at the angles distinct; aperture subquadrangular, or subrhombic and contracted; lip very profoundly notched or divided at each corner, so as to form four triangular flaps or appendages, with inflected lateral margins. Surface ornamented with numerous fine, crowded, transverse costæ, or striæ, which arch slightly towards the aperture in crossing each side, without any interruption or backward curve at the obscure mesial sulcus; costæ regularly crenate, and separated by slightly wider depressions near the middle of the shell, but much more crowded towards the aperture; depressions between the costæ, with very obscure, minute transverse furrows, coincident with the crenulations of the costæ.

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* Some of the specimens show some indications of very fine, crowded, radiating striæ, but these appear rather as if caused by the pressure and slipping of the matrix.

Length about 4.25 inches; greatest breadth, measuring diagonally across between opposite angles of an obliquely compressed specimen, 1.63 inches; greatest breadth of one side, 1.23 inches. Number of costæ in the space of 0.20 inch, near the middle of the shell, 10; do., near the aperture, 20 inch. Number of crenulations in the same space on each of the costæ, 20.

In general appearance the species of this genus often present comparatively little difference, and not unfrequently they so closely resemble each other in their ornamentation as to require a careful comparison to distinguish them. Probably the most marked peculiarity of this species is the presence of a deep, sharply defined notch at each corner of the aperture in the lip, extending down nearly an inch from the margins of the aperture, and widening upwards, so as to divide the lip into four subtriangular flaps, which bend a little inwards, so as to contract the aperture and cause the widest part of the shell to be an inch or more below its upper extremity. Our specimen is not in a condition to show whether these flaps are pointed or truncated at the extremity.

This species will be readily distinguished from our *C. multicostata*, by its coarser and more widely separated, as well as more coarsely crenate striæ, even where the deep notches of its lip cannot be seen.

It is possible this may be the form figured by Dr. Emmons in his Manual of Geology, under the name *C. Verneuilii;* but as he gave no description, and but a rough wood-cut of the species so named by him, we have no means of knowing its characters. His figures, however, would seem to represent a more slender, or less rapidly expanding form, with less arching transverse striæ.

Locality and position—Keokuk division of the Lower Carboniferous series, Hamilton, Illinois.

CEPHALOPODA.

GENUS NAUTILUS, Linn.

NAUTILUS (DISCITES) DISCIFORMIS, M. and W.

Pl. 18, Fig. 1.

Nautilus (Discites) disciformis, MEEK and WORTHEN, 1865. Proceed. Acad. Nat. Sci., Phila., p. 261.

SHELL attaining a rather large size, discoid, much compressed; umbilicus shallow, a little wider than the dorso-ventral diameter of the outer volution, and showing all the inner turns. Whorls about three and a-half, nearly contiguous, or very slightly embracing, nearly flat on each side, the greatest convexity being about half-way between the middle and the inner side, from which point the sides round into the umbilicus, and converge to the periphery, which is truncated, narrow and concave. Septa closely arranged, crossing the sides of the whorls with a broad, graceful, backward curve, more abruptly flexed in the same direction on the truncated periphery, so as to form there a kind of subtrigonal lobe about as deep as wide; they are also sometimes a little curved backwards on the inner side of the whorls. Last or body chamber long, or forming about half the outer volution; others shallow, or usually about equaling one-fifth the dorso-ventral diameter of the volutions at the point of measurement. Siphuncle small, suboval, located about its own diameter outside of the middle of the whorls. Aperture and section strongly compressed, subovate, the inner side being rounded, and the outer side, which is much narrower, truncated, somewhat emarginate, and biangular. Surface unknown.

Greatest diameter across the disc, 8.50 inches to 9 inches; dorso-ventral of the outer volution, near 3 inches; greatest convexity of whorls, about 1.50 inches; breadth of truncated periphery, 0.68 inch.

In size, form, proportions, breadth of umbilicus, etc., as well as in the arrangement and curvature of its septa, this species seems to agree almost exactly with *N. discus*, of Sowerby. If that species has been correctly figured and described, however, our shell presents the important difference of having its siphuncle located a little outside of the middle, instead of near the inner margin of the whorls.

Locality and position—Niota, Hancock county, Illinois. Keokuk division of the Lower Carboniferous series.

NAUTILUS (TEMNOCHEILUS) NIOTENSIS, M. and W.

Pl. 19, Fig. 3.

Nautilus (Temnocheilus) Niotensis, MEEK and WORTHEN, 1865. Proceed. Acad. Nat. Sci., Phila., p. 260.

SHELL attaining a large size, globose-subdiscoidal; umbilicus deep and (considering the lateral carina of the volutions on its margin) about twice the dorso-ventral diameter of the outer turn. Volutions about three, contiguous but not embracing, broadly rounded over the dorsal and ventral sides, and prominently angular around the middle of each lateral margin; section transversely elliptic, the two extremities of the ellipse being angular. Septa rather distinctly concave, and distant on the outer side less than half the dorso-ventral diameter of the whorls, making a broad backward curve in crossing the inner and outer sides of the whorls, and curving forward to each of the lateral angles; siphon piercing the septa less than its own breadth outside of the middle. Surface and aperture unknown.

Greatest diameter, measuring across the disc, about 8.50 inches; convexity, or transverse diameter of the whorls, 5 inches; dorso-ventral diameter of the last volution, about 3 inches.

This species belongs to a group of Carboniferous *Nautili*, including *N. coronatus*, McCoy, *N. biangulatus*, *N. multicarinatus* and *N. cariniferus*, Sowerby. These shells are characterized by having a broad, deep, open umbilicus, showing all the volutions, with the outer side of the whorls broad or flattened, and the middle of each lateral margin prominently angular; the angle being sometimes nodose, while the transverse diameter of the volutions is always greater than the dorso-ventral. The siphon in these shells is generally, or perhaps nearly always, between the middle and the outer side of the whorls. Although Prof. McCoy included a much wider range of forms in his group *Temnocheilus*, it should probably be restricted to such species as those mentioned above, all of which were originally included in the group by Prof. McCoy.

Specifically, our shell is perhaps most nearly allied to *Nautilus cariniferus*, of Sowerby, (Min. Conch., p. 482, fig. 3,) though differing in its proportionally wider umbilicus, merely contiguous volutions, and particularly in never having longitudinal ridges on the outer side of the whorls, at any stages of growth. It also differs in having its septa crossing the outer side of the whorls with a broad backward curve, instead of passing nearly straight over.

Locality and position—Niota and Warsaw, Illinois; Keokuk division of the Lower Carboniferous.

NAUTILUS (SOLENOCHEILUS) LEIDYI, M. and W.

Pl. 18, Fig. 2.

Nautilus Leidyi, MEEK and WORTHEN, 1865. Proceed. Acad. Nat. Sci., Phila., p. 262.

THE only specimen of this shell we have seen consists of the non-septate portion, forming about one-third of a volution. It indicates a sub-globose form for the entire shell, and shows that the umbilicus was deep, with rather abrupt walls, and about as broad as three-fourths the dorso-ventral diameter of the body whorl at the aperture. From the curve, and rapid increase in the size of the outer chamber, it is evident there could not have been more than about two and a half volutions, which are rather broadly rounded over the dorsum and sides to the margins of the umbilicus, into which the sides round rather abruptly. Towards the aperture, the steep, somewhat flattened inner side of the volution forming the walls of the umbilicus meets the lateral margins, so as to form a kind of pinched prominence, that must have imparted a peculiar angularity to the inner margins of the aperture on each side. Just outside of this prominence the ventro-lateral sides of the outer whorl at the aperture are a little flattened. The aperture is one-fourth wider than the dorso-ventral diameter, and forms about three-fourths of a circle, being deeply rounded on the dorsal side, much flattened within, and angular, or apparently abruptly sinuous at each inner lateral margin. Those angles at the inner lateral margins seem even to have projected out somewhat, as in the *Argonauta gondola*, of Adams, though probably not to the same extent. The lip is rather deeply sinuous at the middle of the dorsal side; and the septa were moderately concave, and slightly arched backwards on each side. (Siphuncle and finer markings of the surface unknown.)

Greatest diameter of the shell, about 3.75 inches; greatest breadth (at the inner side of the aperture), 2.65 inches.

As we have not seen the siphuncle of this species, we are not sure that it belongs to the sub-genus *Solenocheilus*, but from its similarity in several respects to the species we have described under the name *capax*, which apparently has a dorsal siphuncle, we are led to infer that it probably possesses the same character. It differs from that shell, however, specifically, in having its body whorl less rapidly expanding, and without a depression along the inner side for the reception of the inner whorls.

The specific name was given in honor of Prof. JOSEPH LEIDY, of Philadelphia.

Locality and position—Warsaw, Illinois; Keokuk division of the Lower Carboniferous series.

ARTICULATA.

GENUS PHILLIPSIA, Portlock.

PHILLIPSIA (GRIFFITHIDES) PORTLOCKII, M. and W.

Pl. 19, Fig. 6.

Phillipsia (Griffithides) Portlockii, MEEK and WORTHEN, 1865. Proceed. Acad. Nat. Sci., Phila., p. 268.

ENTIRE outline sub-ovate. Cephalic shield sub-semicircular, nearly twice as wide as long, moderately convex, rounded in front and straight behind, with posterior lateral angle terminating in short, pointed, spine-like appendages extending back to the third thoracic segment. Glabella ovate, tumid, contracted and depressed behind, widest and most convex or ventricose anteriorly, where it is about one-third narrower than its length from the neck segment to its rounded front, which is not margined by a projecting rim; very distinct from the cheeks in consequence of its greater convexity; posterior lateral lobes small, much depressed, and isolated by the oblique lateral furrows in the front being so directed as to intersect the neck furrow; immediately in front of these there are on each side faint traces of another small, very obscurely defined, lateral lobe; anterior lobe ovate, ventricose, and comprising more than nine-tenths of the whole; neck furrow deep and broad; its continuation across the posterior side of the cheeks distinct, straight, and terminating at the lateral furrows of the cheeks; neck segment prominent, twice the size of the thoracic segments, and equaling the greatest transverse diameter of the glabella in front, but more depressed. Eyes in the form of somewhat oval, ventricose tubercles, considerably lower than the glabella, from which they are separated by rather wide, distinct depressions, placed about half their length in advance of the posterior margin of the cheeks, and without visible facets; palpebral lobes depressed, not covering the eyes, but merely connecting with their inner sides, so as to leave the visual area forming an almost isolated tubercle. Cheeks sloping from the eyes into a broad, deep marginal sulcus, which is not continued around the front of the glabella, but extends back a little upon the lateral spine; outside of this there is a thick, distinctly striated marginal rim, which becomes very nearly obsolete around the front of the glabella. Facial sutures cutting the anterior margin nearly on a line with the eyes, but curving so as to leave a small semi-circular wing on each anterior lateral margin of the glabella; behind they intersect the posterior margin of the cheeks about midway between the lateral angles and the neck segment, but nearer the latter. Thorax nearly as long as the glabella, exclusive of the neck segment, distinctly trilobate; axil lobe slightly wider than the lateral lobes, rounded and rather prominent; its segments narrow and straight, or not arched forward. Lateral lobes more depressed, somewhat flattened on the inner side, rounding down to the lateral margins; segments duplicated by a nearly mesial furrow extending from their inner ends out to or a little beyond the undefined knee, beyond which they are obliquely flattened for folding together, and rounded at their extremities. Pygidium a little more than one-fourth wider than long, rather distinctly convex, rounded behind, and more or less straight in front, with anterior lateral angles obliquely truncated and a little rounded. Mesial lobe very prominent and well defined, rounded above, and a little flattened or furrowed on the sides; as wide anteriorly as the lateral lobes, tapering and declining somewhat posteriorly to an abrupt, obtuse, prominent termination; about half its own greatest anterior breadth within the flattened margin; segments fourteen or fifteen, distinctly defined, smaller than those of the thorax. Lateral lobes depressed below the mesial lobe, somewhat flattened on the inner side, and sloping to the rather narrow and more flattened border; segments ten, somewhat oblique, well defined for three-fourths of the distance out, and thence less distinctly so, to within a short distance of the margin; a few of the anterior ones with an obscure longitudinal furrow. Surface granular, the granules being largest on the posterior portions of the glabella, palpebral lobes and neck segment. On the segments of the axial lobe, both of the thorax and pygidium, as well as on those of the lateral lobes, they are very small, and regularly disposed, so as to form a single row on each segment.

Entire length, 1.19 inches; breadth of head, about 0.80 inch; length of pygidium, 0.44 inch; breadth of do., 0.56

inch; length of thorax, 0.33 inch; breadth of do., 0.60 inch.

This species is remarkable for the structure of its eyes, which, instead of being, as usual, covered by the palpebral lobes, have the form and appearance of distinct oval tubercles, with the small, depressed palpebral lobes merely connecting with their inner sides. We have not been able to see any traces of facets in the eyes, even by the aid of a good lens, but they doubtless existed beneath the transparent shell covering the eyes.

We know of no species with which it could be confounded. With the exception of the above mentioned peculiarities of the eyes, it agrees well with the characters of *Griffithides*, and doubtless must be called *Griffithides Portlockii*, if that group is to be retained as a distinct genus.

Named in honor of Col. J. E. PORTLOCK, of the Royal Ordnance Survey of Ireland, and the author of the genus.

Locality and position—Warsaw, Illinois; Keokuk Limestone of the Lower Carboniferous series.

PHILLIPSIA (GRIFFITHIDES) BUFO, M. and W.

Pl. 15, Fig. 10.

Phillipsia (Griffithides) bufo, MEEK and WORTHEN, 1870 Proceed. Acad Nat. Sci., Phila., p. 52.

ENTIRE outline elliptical, the breadth being to the length as 75 to 130. Cephalic shield forming more than a semicircle, round in front and nearly straight behind; posterior lateral angles terminating in short, abruptly pointed spines extending back to the anterior edge of the thoracic segment. Glabella rather depressed convex, wide anteriorly and narrowing posteriorly to the neck furrow, just in front of which, and connected with the palpebral lobes on each side, it has a single small, obscure lateral lobe; neck furrow broad and well defined, both across the glabella and across the posterior margins of the cheeks; neck segment rather wide, depressed below the level of the highest part of the glabella in front of it. Eyes of moderate size, reniform, nearly as prominent as the glabella, placed but little in front of the continuation of the neck furrow across the cheeks, apparently smooth, but showing when the outer crust is removed, numerous very minute lenses beneath. Cheek sloping off rather abruptly from the eyes to the thickened margin, which does not continue around the front of the glabella; facial sutures cutting the anterior margin in front of the eyes before, and a little outside of them behind. Thorax nearly twice as wide as long, distinctly trilobate; mesial lobe but moderately prominent, nearly twice as wide as either of the lateral lobes, its eight segments merely rounded, and without furrows. Lateral lobes narrow; pleuræ curving moderately downwards at less than half their length out from the axial lobe, but not distinctly geniculated, each provided with a furrow extend- nearly half way out. Pygidium approaching semi-cirular, with the anterior lateral angles obliquely truncated; mesial lobe but slightly wider anteriorly than the lateral; segments about eleven; lateral lobes with eight or nine segments. Surface finely granular, the granules being most distinct on the glabella, and the segments of the mesial lobe of the thorax.

This species will be at once distinguished from our *P. Portlockii*, from the same horizon, by its much broader and less ventricose glabella, and the peculiar tuberculiform eyes of that species, as well as by the broader and less prominent mesial lobe of the pygidium, in the form under consideration.

Locality and position—Crawfordsville, Indiana; Keokuk division of the Lower Carboniferous series.

FOSSILS OF THE ST. LOUIS GROUP.

ECHINODERMATA.

Genus BARYCRINUS.

Barycrinus spectabilis, M. and W.

Pl. 20, Fig. 8.

Barycrinus spectabilis, Meek and Worthen, 1869. Proceed. Acad. Nat. Sci.

Body attaining a large size, rather deeply cup-shaped, though wider than high; truncated below for the attachment of the very large column, and with sides moderately expanding upward. Base basin-shaped. Basal pieces rather large, nearly twice as wide as high, pentagonal in form, with mesial angle above, deeply impressed, the impression being also continued down the middle to the lower edge, with a broad prominence or ridge on each of its sides, also extending to the lower edge, where they each terminate in a little angular projection, while the lateral margins are strongly and abruptly beveled, so as to form deep, wide notches at the sutures. Subradial pieces large and hexagonal, excepting one on the anal side, which is heptagonal; all very profoundly impressed at the corners, so as to form strong radiating ridges, extending one to each of the sides, to connect with those on the other contiguous plates; sometimes these ridges terminate near the central region, in sharp, pinched-up nodes. First radial pieces about twice as wide as high, generally a little wider than the subradials, pentagonal in form, with superior lateral angles more or less truncated, and slightly projecting at the edge; each with a broad, very shallow sinus above for the reception of the second radials, more than three-fourths as wide as its upper margin, while the deep impression at the lower angles forms two broad, strong ridges, extending downward to connect with those on the subradials; sometimes these terminate near the middle above, in sharp, pinched-up, diverging nodes, or short carinæ, while between these and the superior lateral, truncated angles, one or two other sharp prominences are sometimes seen. Second radial pieces extremely short, or almost transversely linear, and not always entirely filling the broad, shallow sinuses in which they rest. Third radials triangular, a little higher in the middle than the first, but wedging to a very thin edge on each side, or even sometimes thinning out so as to let the first brachial pieces rest at their lateral edges partly on the first and partly on the second radials. Anal piece of moderate size, quadrangular in form, a little wider than high, and resting on the upper truncated edge of the heptagonal subradial; while its own upper edge is truncated entirely across, nearly on a level with the superior lateral angles of the first radial on each side. Arms two from each ray, rather long, rounded and tapering; very stout below, where they are composed of thin, short, wide pieces, the first two of which in each pair of arms are joined together at their inner ends; above these the arms of each ray diverge more or less from each other, and throw off alternately, on each side, stout armlets from every second piece. Arm pieces above the wide ones at the base somewhat longer in proportion to breadth than the latter, and more wedge-formed, with each a little pinched up or angular ridge or projection on each side, ranging transversely to the arms, that is, inward and outward. Armlets stout, tapering, and usually about eight or nine to each side of each arm, nearly half as thick as the arms just above where they are given off; composed of pieces of nearly the same form as those of the arms, but generally showing a slight disposition to become a little zigzag, and, at least some of them, throwing off alternately on each side a series of smaller secondary armlets, exactly as they are themselves given off by the arms. Secondary armlets showing a slight zigzag appearance, from the greater thickness and prominence of every second piece on opposite sides, so as to appear as if they may give off a tertiary series of armlets or pinnulæ, though the specimen does not show these, if they exist. Column very stout, nearly round, and composed, at least for about three inches or more below the base, of alternating thin, and somewhat thicker pieces, the latter of which project outward a little beyond the others, and show a slight disposition to become nodular, or irregularly thickened on the edges. Internal cavity large, or equaling about half the diameter of the column itself, and showing an obtusely sub-pentagonal transverse section, the angles being rounded. Longitudinal sutures dividing the column into five sections, partly anchylosed, but still distinctly visible.

Hight of body, about 1 inch; breadth, about 1.70 inches; length of arms, 3.80 inches; thickness of do. at the base, 0.40 inch; thickness of column near base, 0.60 inch.

This fine, large species seems to be most nearly allied to *B. Thomæ*, (=*Cyathocrinus Thomæ*, Hall,) from the Warsaw Limestone, but differs in having the impressions at the corners of its body plates, and the ridges between the same, greatly more strongly defined, and its arms much stouter and more rounded below. Its column is also proportionally stouter, and has a more obtusely pentagonal internal cavity. The typical specimens of *B. Thomæ*, which are now before us, are not in a condition to show the arms all the way up, but as far as they can be seen, they are proportionally more slender, and we can scarcely doubt but that they will show other corresponding differences in the details of their structure, when better specimens can be compared. We have ascertained, however, that the arm pieces of the typical specimens of *B. Thomæ* have on their sides the same kind of little angular projections seen on our species, which character was not mentioned in the description of Prof. HALL'S species.

The peculiarity of having the corners of the body plates impressed so as to form large ridges, or prominences on the plates, is very common in this group of crinoids, but it differs in degree, and other details, in the various species in which we find other corresponding differences in other parts. It is more strongly defined in the species here described, and the ridges are more angular than in any other species known to us. This species is also the first of the group in which we have clearly seen secondary armlets springing from the first, as the latter are given off from each main arm; but since seeing this character in this species, we think we have seen indications of it in some others.

Locality and position—Otter Creek, Jersey county, Illinois; from the St. Louis group, of the Lower Carboniferous.

GENUS POTERIOCRINITES.

POTERIOCRINITES HARDINENSIS, Worthen Ms.

Pl. 20, Fig 10.

BODY above the medium size, urn-shaped, base large, squarely truncated, and entirely covered by the first columnar joints. Basal plates pentagonal, wider than high, and but slightly spreading toward their summits. Sub-radials nearly equal in size, four of them hexagonal and two heptagonal. Anal plates two, the first about half the size of the sub-radials, the other much smaller, and both pentagonal. The first radials wider than high, except the anterior one, which is narrower, the width and hight being in that about equal. Arm plates thin and flat, so far as they are shown in the specimen, there being from two to four above the first radials on each ray. Column consisting at the top of very thin, circular plates firmly anchylosed together, and very gradually decreasing in size below its junction with the base.

Locality and position—Uppermost beds of the St. Louis Limestone; Roseclare, Hardin county, Illinois.

SUB-GENUS SCAPHIOCRINUS.

SCAPHIOCRINUS HUNTSVILLÆ, Worthen Ms.

Pl. 20, Fig. 1.

BODY small, cup-shaped, gently swelling from the base to the top of the first radials. Basal plates minute and hidden beneath the upper joint of the column. Sub-radials rather small, about as wide as long, and hexagonal so far as they are shown in the specimen under examination. First radials wider than high, second radials higher than wide, constricted on their sides, and gradually swelling to the base of the acute angle at their summits, where they give support to a pair of arms composed of wedge-formed pieces. Some of the arms continue single to their extremities, while others bifurcate on the eighth and tenth plates above the second radials, and all give off pinnulæ from their inner margins.

This species is somewhat closely allied to *S. decabrachiatus*, of Hall, but differs essentially in the bifurcation of the arms.

Position and locality—St. Louis Limestone? near Huntsville, Alabama.

SUB-GENUS ZEACRINUS.

ZEACRINUS ARBOREUS, Worthen Ms.

Pl. 20, Fig. 5.

BODY small, depressed basin-shaped below the top of the first radials. Base deeply concave, concealing the minute basal plates in the cavity occupied by the columnar facet. Sub-radials about as wide as long, four hexagonal and one heptagonal, the one on the anal side a little larger than the others, and supporting on its upper angle an anal piece about half its own size, above which are two more of nearly the same size, and all pentagonal. First radials wider than high, slightly beveled on their upper margins, leaving a gaping suture between them and the second radials. Second radials wider than high, except the anterior one, which is narrower, and is succeeded by three more short sub-radials, the upper one of which gives off two arms, which bifurcate again on the eighth plate above. In the other four rays the arms start from the opposite sides of the second radials and bifurcate first on the sixth plate, and again on the eighth and sixteenth plates above. Indications of rather indistinct nodes are to be seen on the plates of the body, as well as on the lateral sides of the arms. The upper extremity of a comparatively large ventral tube is to be seen on one side of the specimen, the diameter of which at the summit is about equal to the diameter of the body at the top of the first radial plates. The plates forming the summit of this ventral tube, or proboscis, are produced into nodes and short spines.

Position and locality—St. Louis Limestone? near Huntsville, Alabama.

ZEACRINUS CARINIFEROUS, Worthen Ms.

Pl. 20, Fig. 4.

BODY small, depressed basin-shaped, or about three times as wide as high to the top of the first radials; base concave and hidden by the column; subradials about as wide as high, three hexagonal and two heptagonal; first radials short, more than twice as wide as long, with a sharp carina extending quite across their upper margins, and joined near the middle by two similar ones coming up from the lower margins of each plate, thus dividing the surface of each first radial piece into three nearly equal triangular spaces. Second radials about two-thirds as long as wide, and ornamented like the first radials with a carina across their lower margins, and a similar one extending upward in the center of the plate nearly to the acute upper angle. First and second radials pentagonal as far as can be seen. Anal plates five or six determinable, and all apparently hexagonal. Arms composed of a single series of wedge-formed pieces, two to each ray, bifurcating first on the fourth or sixth piece, and again on the eighth, and some of the branches bifurcate a third time on the sixth or eighth piece. The anterior ray bifurcates only once, apparently about the eighth piece above the second radial.

Some indications of an inflated ventral tube may be seen, not quite as long as the arms, the apex of which is formed of spiniferous plates.

Locality and position—Same as the last.

This species is nearly related to *Z intermedius*, Hall, but differs in the ornamentation of its body plates and in the mode of bifurcation of its arms.

ZEACRINUS COMPACTILIS, Worthen Ms.

Pl. 21, Fig. 5.

BODY of medium size, and to the top of the first radial pieces forming a nearly flat pentagonal disc. Base a little concave, the basal pieces partly hidden by the first columnar joint. Subradials very small, pentagonal and hexagonal, and deeply inserted between the first radials. First radial pieces comparatively large, nearly twice as wide as long, four hexagonal and one pentagonal, and truncated entirely across their upper margins for the reception of the second radials. Second radial pieces nearly as large as the first, and all but the one on the anterior ray with their upper angles produced into a prominent obtuse point, or node, against and partly upon which the third radial pieces rest. Third radials on four of the rays about twice as wide as long, and two to each ray, giving origin to two arms composed of very thin, flat, nearly circular pieces, of which there are from four to six in each arm. These are succeeded by a thick protuberant axillary piece like the second radials, (except that the nodes upon these point outward instead of upward,) upon which all the arms bifurcate again, the lower piece in each bifurcation being more than twice as long as the succeeding ones. The third radial on the anterior ray is not protuberant, and smaller than those in the other rays, supporting four thin arm-plates, above which there is a thick protuberant axillary piece upon which the ray bifurcates as in the others. First anal piece rather long and narrow, hexagonal, and resting upon one of the small basal pieces. Second anal, as far as can be seen, about as wide as long, and hexagonal. Surface of all the plates finely rugose.

This species bears some resemblance to *Cyath. florealis*, Yandell and Shumard, Contrib. to the Geol. of Ky., but differs in the flat disc-like and pentagonal form of the body, as well as in the form and arrangement of its arms.

Locality and position—Cumberland county, Ky. Lower Carboniferous. For the fine specimen from which the foregoing description was drawn I am indebted to Prof. E. T. Cox, now State Geologist of Indiana.

GENUS DICHOCRINUS, Munster.

DICHOCRINUS CORNIGERUS, Shumard?

Pl. 20, Fig. 6.

Dichocrinus cornigerus, SHUMARD. Trans. St. Louis Acad. of Sci., 1860, p. 72.

This form, which seems to be identical with Shumard's species above cited, was found in the upper bed of the St. Louis group near Roseclare, Hardin county, Ill.

GENUS GRANATOCRINUS.

GRANATOCRINUS GLABER, M. and W.

Pl. 20, Fig. 11.

Granatocrinus glaber, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 91.

BODY very small, pentagonal-subglobose, being somewhat wider than long, and rather broadly truncated below, with the spaces between the rather prominent pseudo-ambulacral areas almost flat near the middle, and more or less concave below. Base about even with the most prominent part of the lower ends of the radial pieces, nearly flat, and very distinctly pentagonal, or almost pentapetalous in outline. Radial pieces forming about three-fourths the actual hight of the body, abruptly incurved below to connect with the base, and all divided quite to the lower side of the body by the pseudo-ambulacral areas. Interradial pieces of moderate size, or about one-third as long as the body, measuring over the curve of the sides from their upper ends to the base; triangular in form and nearly as wide as long, all strongly incurved above; anal piece shorter than the interradials below the anal opening. Pseudo-ambulacral areas rather narrow, tapering slightly from above, and nearly as convex as the margins of the radials on each side. Pore pieces about twenty-five to thirty on each side of the mesial furrow of each area; supplementary pore pieces unknown; lancet pieces apparently not showing externally. Summit depressed in the middle; central and anal openings comparatively rather large; so-called ovarian pores of moderate size, situated one on each side of the inner end of each interradial piece, and of course two others as usual opening into the anal aperture.

Surface apparently quite smooth, even as seen under a magnifier, but probably when entirely unworn marked by microscopic longitudinal striæ.

Hight of one of the largest specimens, 0.21 inch; breadth, 0.23 inch; breadth of pseudo-ambulacral areas, 0.04 inch; do. of spaces between the same, at the widest part, 0.13 inch.

This little species is so very clearly distinct from all others known to us that it is unnecessary to compare it with any of those yet described. Its most characteristic features are its small size, smooth surface, flat space between the pseudo-ambulacral areas, and nearly even pentapetalous base.

We have before us nine specimens, of various sizes, all agreeing in the characters given excepting one, which, from abnormal development, has only four pseudo-ambulacral areas. As this agrees with the others, however, exactly, in all its specific characters, it is evidently a monstrosity of the same species, produced by the non-development of one of the radial pieces, by which means two of the pseudo-ambulacral fields are, as it were, welded together, to form one larger than any of the other three.

Locality and position—St. Louis division of the Lower Carboniferous series, in Hardin county, Illinois.

MOLLUSCA.

LAMELLIBRANCHIATA.

LITHOPHAGA? PERTENUIS, M. and W.

Pl. 22, Fig. 1.

Lithophaga? pertenuis, MEEK and WORTHEN, 1865. Proceed. Acad. Nat. Sci., Phila., p. 245.

SHELL slender, elongated, narrowing anteriorly, extremely thin, moderately convex in the central and anterior regions, more compressed and cuneate behind; posterior margin narrowly rounded in outline; anterior margin extremely short and very narrowly rounded; basal margin straight along the middle and curved up gradually towards the extremities; hinge line straight, not exactly parallel to the base, and apparently about half as long as the shell, passing imperceptibly into the posterior dorsal margin. Beaks almost terminal, very oblique, and nearly obsolete. Surface smooth, or with only faint traces of fine, concentric striæ, and very obscure, undefined, concentric undulations.

Length, 1.73 inch; hight, 0.62 inch; convexity, 0.50 inch.

This species has nearly the form and general appearance of that which we have with doubt referred to *Lithophaga? (Modiola) lingualis*, of Phillips, from the Keokuk Limestone, but may be distinguished by its smooth surface, which never shows the distinct thread-like concentric striæ and regular wrinkles of that shell. As we know nothing of the hinge and interior of these species, we merely place them provisionally in the genus *Lithophaga*, from the similarity of the external characters to some of the recent species of that genus.

Locality and position—Warsaw, Illinois; Warsaw division of the Lower Carboniferous series.

GENUS MYALINA.

MYALINA ST. LUDOVICI, Worthen Ms.

Pl. 22, Fig. 3.

SHELL below the medium size, sub-quadrate, oblique; length about once and a half the width; hinge straight, and equaling the greatest width of the shell below; basal margin regularly rounded; beak of the left valve pointed, and curving obliquely forward. Surface marked by regular concentric laminæ from the beak to the basal margin, the distance between them gradually increasing from the beak downward.

This species may be readily distinguished from any other known to us in the Lower Carboniferous Limestones, by the strong concentric laminæ upon its surface.

Position and locality—St. Louis Limestone; Alton, Illinois, and St. Louis, Missouri.

GENUS CHÆNOMYA, M. and H.

CHÆNOMYA? RHOMBOIDEA, M. and W.

Pl. 22, Fig. 4.

Chænomya? rhomboidea, MEEK and WORTHEN, 1865. Proceed. Acad. Nat. Sci., Phila., p. 250.

SHELL rather small, short, moderately convex; outline rhombic, as seen in a side view; basal and dorsal margins nearly straight and parallel, the former very abruptly curved upwards behind, and more gradually in front; anterior side very short and truncated, or a little rounded; posterior side distinctly truncated (obliquely) nearly the entire breadth or hight of the valves, gaping but not dilated;

dorsal margin less than the entire length of the shell, and inflected so as to form a narrow but well defined escutcheon, or false area. Beaks narrow, or compressed antero-posteriorly, rather pointed, prominent and incurved, nearly terminal, or placed directly over the anterior margin. Umbonal slopes oblique, very prominent near the beaks, but less so along the central and posterior ventral region; anterior and ventral regions abruptly cuneate, with a very faint, undefined impression extending from the beaks obliquely backward toward the middle of the base, just in front of the umbonal prominence. Surface ornamented with small, regular, concentric undulations, with apparently very faint indications of very small, radiating striæ.

Length, 1.17 inches; hight from ventral to cardinal margin, 0.80 inch; do. to summit of beaks, 0.90 inch; convexity, 0.65 inch; gap of valves behind, 0.25 inch.

Although this species seems to agree in most of its known characters with the types upon which the genus *Chænomya* was established, it differs in being a proportionally shorter, less widely gaping shell, while its beaks are more prominent and oblique. As we know nothing of its hinge or interior, or of its finer surface markings, it was only provisionally that we at first placed it in the genus *Chænomya*, and that we now leave it there. Possibly, we should call it *Allorisima rhomboidalis*, or *Sedgwickia rhomboidalis*.

Locality and position—St. Louis Limestone, of the Lower Carboniferous series; near Alton, Illinois.

PTEROPODA.

GENUS CONULARIA.

CONULARIA MISSOURIENSIS, Swallow?

Pl. 22, Fig. 5.

Conularia Missouriensis, SWALLOW, 1860. Trans. St. Louis Acad. Sci., Vol. I, p. 637.

SHELL attaining a large size, presenting the usual elongated, four-sided, pyramidal form, two of the opposite sides being wider than the others, with their lateral margins diverging towards the aperture at an angle of about eighteen degrees, while those of the narrower sides diverge at an angle of about twelve or fifteen degrees; transverse section (in a distorted specimen) rhombic; angles at the four corners rather deeply furrowed; sides without a distinct mesial furrow. Surface marked by comparatively strong, rather prominent, apparently smooth, sharp, transverse costæ, about half as wide as the rounded furrows between; in passing across the sides these curve more or less upwards toward the aperture, and are often interrupted and alternating in the middle; costæ and spaces between, so far as can be seen, without crenulations.

Length of a specimen incomplete at both extremities, 6.10 inches; breadth of one of the wider sides at smaller end, 0.52 inch; do. of same at larger end, 1.88 inches; breadth of narrow sides at smaller end, about 0.50 inch; do. of same at larger end, about 1.30 inches.

From a comparison with a tracing made from Prof. SWALLOW'S type of his *C. Missouriensis*, we are led to regard this as his species, though as his specimen is rather imperfect, it is possible some specific differences might be observable, if we could compare good specimens. The rhombic form in both examples is doubtless due to oblique pressure, which has probably imparted the carinated character to the acute lateral edges mentioned by Prof. SWALLOW.

The species is most remarkable for its coarse, rather distant, and apparently smooth transverse costæ and large size.

Locality and position—Prof. SWALLOW'S typical specimen was obtained from some of the (upper?) members of Lower Carboniferous Limestones of Cooper county, Missouri. The specimen from which our figures and description were prepared was found in the Warsaw division of the Lower Carboniferous Limestone series, at Warsaw, Illinois.

CEPHALOPODA.

Genus NAUTILUS.

Nautilus (Temnocheilus) Coxanus, M. and W.

Pl. 23, Fig. 1.

Nautilus (Temnocheilus) Coxanus, MEEK and WORTHEN, 1869. Proceed. Acad. Nat. Sci., Phila.

SHELL rather small, sub-discoid, broadly rounded, or depressed convex over the periphery; umbilicus wide, rather deep, perforated, and showing more than three-fourths of the dorso-ventral diameter of each inner turn; volutions about two and a half to three, very slightly concave along the dorsal or inner side for the reception of the periphery of each succeeding turn within, more or less narrowly rounded (sub-angular in young specimens), and ornamented by about fifteen small nodes around the middle of each side, from which point the inner side rounds very abruptly into the umbilicus; septa separated on the outer or ventral side by spaces one-fifth to one-sixth the transverse diameter of the volutions, at the point of measurement, arching slightly backward in crossing the periphery; body chamber composing about half of the outer volution; siphuncle small, and situated sub-centrally, or somewhat nearer the outer or ventral side; aperture transversely oval. Surface ornamented with distinct, regular, longitudinal, raised lines, or small, revolving costæ, narrower than the rounded furrows between, those along the middle of the ventral or outer side being smaller and more crowded than those toward the lateral regions; crossing all these are numerous very fine, crowded striæ of growth, which curve strongly backward in passing over the periphery, parallel to the margins of the very profound sinus in the lip on the ventral side.*

Greatest diameter of a mature specimen, 2.23 inches;

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* This would be the dorsal side, according to the nomenclature most generally used.

thickness, or transverse diameter, about 1 inch; dorso-ventral diameter of last turn, near the aperture, 0.86 inch.

Among the specimens before us, there are two forms that may possibly belong to distinct species. One of these, which we consider the typical form of the species here described, has the periphery very depressed convex, while in the other it is distinctly more convex, or rounded. As they agree, however, apparently almost exactly in all other known characters, and both forms seem to vary somewhat in the convexity of the periphery, we are inclined to view them as merely varieties, or probably the different sexes of one species. In the more convex form, the lateral nodes seem to be generally a little more inclined to become slightly elongated in the direction of the transverse diameter of the whorls, though this character appears not to be entirely constant. In both forms the longitudinal, or revolving surface ridges and furrows, become nearly or quite obsolete toward the aperture on the body whorl.

Internal casts of this species seem to be almost exactly like specimens figured by European authorities under the name *N. tuberculatus*, Sowerby. As that species, however, attains a much larger size, and has, according to Prof. McCoy's description, a very large siphuncle, while none of the figures or descriptions of it we have seen either show or mention the distinct longitudinal, or revolving costæ, so well defined on the surface of our shell, we can entertain no doubt in regard to its being clearly distinct. It is true, the figures of *N. tuberculatus* alluded to all represent only internal casts, while the longitudinal markings seen on our shell are not indicated on casts of its interior; but it is scarcely possible that such markings should never have been observed, as impressions in the matrix, if not otherwise, had they existed in *N. tuberculatus*.

The specific name of this shell was given in honor of Prof. E. T. Cox, the State Geologist of Indiana.

Locality and position—Waterloo, Illinois, and Greencastle, Indiana; from the St. Louis division of the Lower Carboniferous.

NAUTILUS (SOLENOCHEILUS) COLLECTUS, M. and W.

Pl. 23, Fig. 3 and 4.

Nautilus (Solenocheilus) collectus, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1870, p. 48.

SHELL thin, attaining a moderate size, slightly compressed or subglobose in general form; umbilicus rather small, but deep, perforated, and provided with very abrupt walls, particularly near the aperture. Volutions about one and a half, increasing rapidly in size, and a little wider transversely than their dorso-ventral diameter; moderately embracing, with a subquadrangular section, the angles being rounded, and the lateral and outer or ventral surfaces more or less flattened. Septa moderately concave, distant about one-fourth the transverse diameter of the volutions at the point of measurement, and showing a slight backward curve in crossing the sides and periphery; aperture large, and, as near as can be determined from the specimens, with a subquadrangular or subcircular outline, more or less sinuous on the inner side for the reception of the small inner turn; siphuncle small. Surface smooth, or only showing small lines of growth.

Greatest diameter of a small specimen, with body chamber broken away, 1.70 inch; transverse diameter of same, about 1.25 inch.

As in other species of this group, the small siphuncle is so very nearly in contact with the outer side that in casts where the shell is removed it often gives the appearance of a very narrow, deep lobe along the middle of that side. It is easy to see, however, that this appearance is merely produced by the breaking away of a thin part of the matrix between the siphuncle and the outer shell. None of our specimens are in a condition to show the margins of the lip, but some of them show very clearly the commencement of the protuberance or pinching up of the margin on each side near the umbilicus, evidently terminating at the aperture in the usual spout-like auricles. The lines of growth also show the same by the flexures on each side.

Specifically this shell is probably most nearly allied to our *N. (Solenocheilus) Leidyi*, from the Keokuk division of the Lower Carboniferous, though it differs in having more rapidly expanding and subquadrangular whorls, which are also slightly embracing at the aperture, instead of being merely in contact. Its volutions, however, are much less rapidly expanding than in our *N. (Sol.) capax*, or in *N. Springeri*, of White and St. John, as well as different from both in their subquadrangular form.

Locality and position.—St. Louis division of the Lower Carboniferous series, Greencastle, Indiana, and near Waterloo, Monroe county, Ill.

FOSSILS OF THE CHESTER GROUP.

ECHINODERMATA.

GENUS POTERIOCRINITES.

POTERIOCRINITES BISSELLI, Worthen Ms.

Pl. 21, Fig. 4.

BODY of medium size, obconical, or tapering regularly from the arm bases to its connection with the column, composed of smooth, slightly rounded plates, with well defined sutures. Base small, truncate below, gradually widening upwards, and composed of nearly equal pentagonal pieces about as wide as high; columnar facet with a slight marginal rim, and pentagonal in outline. Subradial plates nearly equal in size, the two on the anal side slightly larger than the others and heptagonal, the other three hexagonal. First radials, four wider than high, and pentagonal, the right hand one on the anal side higher than wide, and hexagonal. Anal pieces four or more, the first three about half the size of the first radials, one pentagonal and two hexagonal, the others smaller and hexagonal. Second radials not well shown, but apparently about as high as the first. Arms composed near their base of rather thick wedge-shaped pieces, which gradually become flat and thinner above. Column composed of rather thin segments near the base, which gradually become alternately thicker below.

Dedicated to the memory of the late Gov. Wm. H. Bissell, as a slight tribute of respect for his manifest interest in the success of the geological survey and the general advancement of science.

Locality and position—Chester division of the Lower Carboniferous, Chester, Illinois.

Sub-genus ZEACRINUS.

Zeacrinus? armiger, M. and W.

Pl. 21, Fig. 3.

Zeacrinus? armiger, Meek and Worthen, 1860. Proceed. Acad Nat. Sci., Phila., p. 27.

Body small and depressed, or nearly basin-shaped, but with the under side rounded, and concave in the middle. Base very small, and nearly or quite hidden in the concavity of the under side. Sub-radial pieces comparatively large, and curving under below, but not tumid or convex; three with a general pentagonal outline, but probably having a sixth obtuse angle at the middle of each below; the other two on the anal side presenting a general hexagonal form, but truncated by the anal pieces in such a manner as to present a heptagonal form, exclusive of the very obtuse angle probably existing at the middle of the under side of each. First radial pieces twice as wide as high, pentagonal in form, and truncated across their entire breadth. Second radials as high as wide, each bearing two arms on their superior sloping sides, and developed into a long, slender, rounded, mucronate spine, which is directed nearly horizontally outward. Anal pieces small, and arranged in a double alternating series, the first or lowest piece being somewhat cuneiform and wedged obliquely down between one of the sub-radials and the under side of the first radial on the left, so as to touch, by a very short side, the next sub-radial on the left; second anal piece resting on the short truncated summit of one of the heptagonal subradials, and connecting on the right with one of the first radial pieces, and on the left with one of the upper sides of the first anal piece, and another piece resting on the latter. Above these, others continue up to connect with the base of the ventral extension of the body. Arms unknown. Surface smooth. Sutures not impressed.

Breadth of body, 0.39 inch; hight of same to top of first radial, 0.17 inch; length of spines formed by the extension of the second radial, 0.40 inch.

In the peculiarity of having its second radial pieces developed into long, slender spines, this species agrees with *Zeacrinus? mucrospinus*, McChesney, from the upper Coal Measures, and may be regarded as a representative form of that curious Coal Measure species, in the upper part of the Lower Carboniferous. It differs, however, from that species specifically, not only in being much smaller and more delicate, but in having its sub-radial pieces much shorter in proportion to their breadth, and distinctly less produced and pointed at the ends. Its anal pieces are also very differently arranged, the first or lower one being wedged down obliquely under the first radial on the *left* instead of under that on the *right* of the anal series, as in *Z. mucrospinus*. It is the first American species of the *Cyathocrinidæ* we have ever seen with this reversed arrangement of the anal series, though Prof. McCoy has represented a similar arrangement of these parts, in an analagous form, from the Carboniferous rocks of Scotland. Until the arms of this crinoid can be seen, it is not possible to determine whether or not it belongs to the genus *Zeacrinus*.

Locality and position—Pope county, Illinois; Chester division of the Lower Carboniferous series.

ZEACRINUS SUB-TUMIDUS, Worthen Ms.

Pl. 21, Fig. 1.

BODY depressed basin-shaped, about twice as wide as high, and composed of thick, massive plates. Base deeply impressed for the reception of the column, which apparently nearly filled the basal concavity, concealing the small basal pieces. Sub-radials massive, strongly protuberant, about as wide as long, and curving inward at their lower extremities, to form the basal concavity, three hexagonal and two on the anal side heptagonal. First radials about once and a half as wide as high, all pentagonal, convex, but not protuberant. First anal piece about once and a half as long as wide, pentagonal and protuberant. Second and third anal pieces smaller than the first, hexagonal and pentagonal, and both strongly convex. Surfaces of all the plates without ornamentation. Arms and column unknown.

Locality and position—Chester division of the Lower Carboniferous series; Bay City, Pope county, Illinois.

ZEACRINUS FORMOSUS, Worthen Ms.

Pl. 21, Fig. 2.

BODY of medium size, depressed basin shaped, and a little more than twice as wide as high. Base small, and impressed for the reception of the column; the first column joint covering about one half the length of the small basal pieces. Sub-radials about as wide as long, three hexagonal and two heptagonal; all curving inward at their lower extremities, to form the concavity of the base. First radials about once and a half as wide as long, all pentagonal except the one on the right of the first anal piece, which appears to have but four angles, and, with the first anal curves abruptly inward on its upper margin. Second radials pentagonal, nearly as long as the first, and on three of the rays seen give origin on their upper sloping angles to two arm pieces in each ray. Surface of all the plates finely granulose and convex, but not protuberant.

Locality and position.—Chester division of the Lower Carboniferous series, Chester, Illinois.

SUB-GENUS SCAPHIOCRINUS.

SCAPHIOCRINUS BAYENSIS, M. and W.

Pl. 20, Fig. 2.

Poteriocrinus (Scaphiocrinus) Bayensis, MEEK and WORTHEN, 1865. Proceed. Acad Nat. Sci., Phila., p. 157.

BODY of medium size, rather depressed obconic below the top of the first radials. Base about twice as wide as high, expanding directly from the head of the column on a line with the subradial and first radial pieces. Basal pieces moderately developed, wider than long, pentagonal, and showing the whole surface of each in a side view. Subradials about three times as large as the basal pieces, somewhat wider than long, three hexagonal, and two on the anal side apparently heptagonal, the angle at the middle of the under side being very obtuse. First radial pieces wider, and a little shorter, than the subradials, all pentagonal, apparently all transversely truncated their entire breadth above. Second radials of nearly the same size as the first, and like them pentagonal, but having the middle angle above, and more salient, while the two superior sloping sides each supports an arm, thus giving origin to two arms to each ray, so far as seen, all of which are nearly in contact all around below, excepting on the anal side.

First anal piece smaller than the subradials, hexagonal in form, and resting between the upper sloping sides of two of the subradials, with its upper right edge supporting one side of one of the first radials, and its left connecting apparently with a second anal piece, the form of which cannot be made out in the specimens seen. In the third range one piece evidently rested upon the upper truncated edge of the first anal piece, but its form and connection with the other pieces on the left have not been determined.

Arms long, and, as far as known, apparently simple after the first division of each ray on the second radial piece; each composed of a single series of wedge-shaped pieces, alternately longer and shorter on opposite sides, but not protuberant on either side; those near the lower part about as long on the longer side as their breadth. Tentacles numerous, rather stout, and composed of joints three or four times as long as wide, and not swollen or dilated at the ends.

Column round, of moderate thickness near the base, where it is composed of alternately thicker and thinner pieces. Surface apparently smooth. Sutures between the first and second radial pieces distinctly gaping, when the arms are folded together.

Hight of body to top of the first radial pieces, 0.25 inch; breadth of do., 0.48 inch; length of arms above the second radials, at least 1.90 inches, and probably more; diameter of column at its connection with the base, 0.13 inch.

This species seems to be closely related to *S. decabrachiatus*, Hall, (Iowa Report, Vol. I, Part II, p. 679, pl. xxv, fig. 1,) but it is larger and more robust, and its second radial pieces differ materially in form, in being nearly or quite twice as wide as long, instead of "nearly once and a half as long as wide." Its body is also much more rapidly expanding upwards, and its basal pieces proportionally about twice as large as those of *S. decabrachiatus*. Other corresponding differences would doubtless also be apparent on comparing specimens of each showing all the parts.

Locality and position—Bay City, Pope county, Illinois. Chester division of the Lower Carboniferous series.

SCAPHIOCRINUS RANDOLPHENSIS, Worthen Ms.

Pl. 21, Fig. 14.

BODY rather small, depressed-obconical below the second radial pieces, rapidly expanding from the base; plates rather thin, their surfaces covered with flattened granules. Base short, scarcely one-fourth as high as wide, columnar facet covering more than half its entire width. Subradials nearly equal in size, four pentagonal, and one hexagonal, as well as can be seen from the crushed condition of the specimen. First radials larger than the subradials, wider than high, except the one on the right of the anal plates, which is smaller and nearly quadrangular in outline, the others are pentagonal. Second radials a little higher than wide, constricted about their middle, and produced into a salient angle above. Arms two to each ray, as far as can be seen in the specimen before us, composed of alternating wedge-shaped pieces, having their thickest margins produced into little nodes. The arms bifurcate on the tenth or twelfth plate above the second radials, continuing thence single to their extremities. Pinnulæ are thrown off from the inner side of the arms on alternate plates, composed of long slender joints.

Locality and position—Chester disvision of the Lower Carboniferous, Chester, Illinois.

GENUS ONYCHOCRINUS.

ONYCHOCRINUS WHITFIELDI, Hall (sp.)

Pl. 20, Fig 3.

Forbesiocrinus Whitfieldi, HALL, 1858. Iowa Report, p. 632. (See Ill. Report, Vol. II, p. 243.)

BODY sub-discoidal, the rays extending out nearly horizontally. Basal pieces very small, or merely resembling a somewhat thickened terminal joint of the column. Subradial pieces comparatively large, all, excepting the hexagonal one on the anal side, having a general pentagonal form, though two or three of the others have the upper salient angle slightly truncated, so as to give them an additional angle. First radial plates a little larger than the sub-radials, about twice as wide as long, pentagonal and hexagonal. Second and third radials as wide as the first, or a little wider, but generally slightly shorter, all, excepting those on the anal side, hexagonal, the latter having the end next the anal series truncated, so as to leave only five well defined angles. Third radials of very nearly the size of the first, all pentagonal, and supporting on their superior sloping sides the secondary radials, upon the second of which another bifurcation takes place, and these divisions bifurcate again (at least in one instance) on the third piece, at which point the arms appear to become free. Interradial pieces ten to each space; interaxillary plates one to each space. Anal plates presenting the usual narrow, finger-like appearance, two of them being seen in place in the type specimen, the first resting upon the subradial, and the second upon the first, while a few others are seen ranged in the same line above, but somewhat displaced. Surface apparently smooth. Column round, and composed near the base of very thin pieces.

Breadth of body to the second bifurcation of the rays, including the interaxillary pieces, 1.30 inches; hight of do., exclusive of the vault, 0.18 inch.

This species is probably most nearly allied to *O. Meeki* (=*Forbesiocrinus Meeki*, Hall,) but has the body rather more depressed, with interradial spaces broader, and occupied by a greater number of pieces, while its radial plates are proportionally narrower. It shows no little accessory patelliform pieces between the radials as far out as they can be traced in the type specimen, but they doubtless exist between the arm pieces.

Prof. HALL compares this species with *Forbesiocrinus Wortheni*, and mentions some of the well defined differences, but appears to entirely overlook the deeply excavated character of its anal space, occupied only by a range of small pieces, resting, like a little arm, upon the subradial, instead of having this space filled with twenty or more plates, like the interradial areas, as in *F. Wortheni*. We have the type specimens of both of these species before us, and that of the species under consideration shows the little isolated range of anal pieces in the middle of the anal area, very clearly, and it is evident they were not suspected to be such by Prof. HALL, who says the anal plates are unknown, while they are not illustrated in his diagram published in the Iowa Report. In short, these two forms belong to the distinct genera or sub-genera *Onychocrinus* and *Forbesiocrinus*.

Locality and position—Opposite Kaskaskia, in Randolph county, Illinois; from the Chester division of the Lower Carboniferous series. By some error, the locality and position given in the Iowa Report are "Keokuk Limestone; Warsaw, Illinois."

GENUS EUPACHYCRINUS.

EUPACHYCRINUS BOYDII, M. and W.

Pl. 21, Fig. 6.

Eupachycrinus Boydii, MEEK and WORTHEN, 1870. Proceed. Acad. Nat. Sci., Phila., p. 30.

BODY much depressed, or twice and a half as wide as high to the top of the first radials, rounded inward above the second radials, and under to the very profound central concavity below; composed of thick, strong, slightly convex plates. Base very small and deeply sunken in the concavity of the under side. Sub-radials comparatively large, convex, and curving upward above, and under below, and then again upward into the concavity of the under side, where each of them has a mesial indentation or notch; each presenting a general pentagonal outline, excepting two on the anal side, which are modified for the reception of the anal pieces. First radials about twice as wide as high, convex, and equaling the sub-radials in breadth, all pentagonal in form. Second radial pieces convex, about half as large as the first, which they do not quite equal in breadth, although they are in contact with each other all around, thus giving a contracted appearance to the body just above the first radials; each about twice as wide as high, pentagonal in form, and bearing on one superior sloping side an arm, while on the other there rests a smaller secondary radial bearing two arms; thus making, as far as can be seen, three arms to a ray, or if the same structure exists in all the rays, fifteen to the entire series. First or sub-anals rather large, nearly quadrangular in form, and resting between the sloping upper sides of two of the sub-radials, under one side of the first radial on the right, and connecting with the second radial on the left, but apparently not always extending up far enough to have its upper angle truncated by one of the succeeding anals above. Second anal piece considerably smaller than the first, and resting upon the upper truncated side of one of the subradials; above these two or three smaller pieces appear between the arms. Surface smooth. Sutures between the body plates rather deep. Arms slightly convex on the outer side, with lateral margins flattened and straight, so as to fit closely together when raised up vertically; each composed below of a single range of wedge-formed pieces, but soon passing into a double alternating series above.

Breadth of body across the middle, 0.90 inch; do. across the second radials, 0.64 inch; hight to top of first radial pieces, 0.40 inch.

This is a very neat, symmetrical crinoid, unlike any other known to us, and remarkable for having its much depressed body rounding in above, at the top of the first radial pieces, so as to be very distinctly narrower across above the top of the first radials than below. Its sides also round very neatly under below, and so far into the deep concavity of the under side that the lower (inner) ends of the subradial pieces curve upward into the mesial concavity nearly as far up as their outer or upper ends. It seems to be the same form figured by YANDELL and SHUMARD, in their "Contributions to the Geology of Kentucky;" (see their fig. 4, *a*, *b*, without a description or name,) from near Grayson Springs, Kentucky.

The specific name is given in honor of Dr. BOYD, of Chicago, to whom we are indebted for the specimen described.

Locality and position—Chester, Illinois; Chester division of the Lower Carboniferous series.

GENUS PLATYCRINITES.

PLATYCRINITES PARVULUS, M. and W.

Pl. 20, Fig. 7.

Platycrin? parvulus, MEEK and WORTHEN, 1865. Proceed. Acad. Natural Sci., Phila., p. 163.

BODY very small, short, sub-cylindrical, or deeply cup-shaped. Base depressed basin-shaped, or several times as wide as high; facet for the attachment of the column about one-third as wide as the base, with a small marginal rim. First radial plates nearly oblong, being longer than wide, with sub-parallel sides; some of them with two obscure linear ridges extending from the middle to the upper side, and slightly diverging to the base; each moderately concave above for the reception of the next range of pieces. Second radial very minute, about twice as wide as long, but not equaling the breadth of the slight concavity in the upper side of the first radials. Third radial pieces slightly wider than the second, and about of the same length, pentagonal, and each supporting an arm on each superior sloping side. Arms each divided on the second piece, beyond which they are simple, at least for four or five pieces above, and composed of a single series of quadrangular pieces, about as long as wide, excepting the first, which is near twice as long as wide. Tentacles apparently comparatively stout. Column near the base nearly or quite round, and composed of very thin pieces. Surface smooth.

Length of body to summit of first radial pieces, 0.12 inch; breadth of do., 0.12 inch; length of arms, about 0.30 inch; thickness of column, 0.02 inch.

This very small species differs remarkably from all the others with which we are acquainted, resembling it in other respects, not only in its small size, but in having two minute radial pieces in each ray, above the larger first radials composing the body, thus making three radials to each ray.

Locality and position—Pope county, Illinois; Chester division of the Lower Carboniferous series.

GENUS AGASSIZOCRINUS.

AGASSIZOCRINUS PENTAGONUS, Worthen Ms.

Pl. 21, Fig. 10.

BODY, viewed from below, pentagonal in outline, base rather large, suture lines distinct, point of attachment for the column small, but distinct. Basal plates comparatively large, pentagonal, their upper angles terminating at the suture between the subradial plates. Subradials large, nearly as wide as high, two heptagonal and three hexagonal, and all flat or slightly concave in the center, giving a pentagonal form to the body. First radials pentagonal, so far as can be seen in the specimen under examination, wider than high, and contracted by curving inward at their upper margins. Second radial or arm plate a little smaller than the first radials, giving off a single arm from the right-hand side, while on the left, there is a third radial or axillary plate, giving origin to two arms on the single ray preserved. Arms, so far as can be seen, composed of rounded plates, tolerably uniform in thickness, with well defined sutures between them.

This species may be readily distinguished from any one hitherto known, by its concave sub-radial plates, and pentagonal outline.

Position and locality—Chester division of the Lower Carboniferous; Chester, Illinois.

AGASSIZOCRINUS CONICUS, O. and S.

Pl. 21, Fig. 8.

Agassizocrinus conicus, OWEN and SHUMARD, 1851. Jour. Acad. Nat. Sci., Phila., n. s., Vol. II, p. 93; pl. 9, fig. 6. Also, Geol. Rep. Iowa, Wis. and Minn., p. 597; pl 5, fig. 6.

Position and locality—Chester division of the Lower Carboniferous; Chester, Illinois.

AGASSIZOCRINUS GLOBOSUS, Worthen Ms.

Pl. 21, Fig. 12.

BASAL plates small, pentagonal? slightly tumid, the upper angle projecting up between the subradials forming a little star. Point of attachment for the column round and very small. Subradial plates large, slightly gibbous, three hexagonal and two heptagonal; hight about one-half greater than the breadth, gradually enlarging from the bottom upwards, so that the greatest diameter is just below the base of the first radials, from which point the body contracts rapidly to the top of the first radials, giving it a globular form. First radials wider than long, four pentagonal and one hexagonal, all abruptly curving inward towards the center. Anal plates four, the lower one large, nearly quadrangular in outline, the second about half the size of the first, the others quite small, and all pentagonal. Arms and column unknown.

Locality and position—Chester division of the Lower Carboniferous, Chester, Illinois.

AGASSIZOCRINUS GIBBOSUS, Hall.

Pl. 21, Fig. 11.

Agassizocrinus gibbosus, HALL, 1858. Geol. of Iowa, Vol. I, p. 686, Pl. 25, Fig. 6.

Locality and position—Chester division of the Lower Carboniferous, Chester, Illinois.

AGASSIZOCRINUS CHESTERENSIS, Worthen Ms.

Pl. 21, Fig. 9.

BODY ovoid, protuberant at the base, and constricted at the base of the arms. Base solid, with no well defined suture lines, but showing a faint trace of the point of attachment for the column. Subradial plates large, nearly flat on their external faces, four pentagonal and two hexagonal, nearly twice as high as wide, and curved slightly inward at their upper extremities. First radials small, pentagonal, about twice as wide as high, and curving inward from their junction with the subradials. Anal plates three, the lower one large, subquadrangular in outline with the upper right hand corner truncated, the other two small and pentagonal.

In general form this species bears some resemblance to *A. gibbosa*, of Hall, from which it may be readily distinguished by its flattened subradials. Arms and column unknown.

Locality and position—Chester Limestone, Chester, Illinois.

GENUS PTEROTOCRINUS, L. and C.

PTEROTOCRINUS DEPRESSUS, L. and C?

Pl. 21, Fig. 13.

Pterotocrinus depressus, LYON and CASSEDAY, 1860. Amer. Jour. Sci., new series, Vol. 29, p. 68.

Position and locality—Chester division of Lower Carboniferous, Kaskaskia, Illinois.

GENUS GRAPHIOCRINUS.

GRAPHIOCRINUS DACTYLUS, Hall.

Pl. 20, Fig. 9.

Graphiocrinus dactylus, HALL, 1860. Geol. of Iowa, Supp. to Vol. I, p. 81.

Locality and position—St. Louis Limestone, Monroe county, Ill.

FOSSILS OF THE COAL MEASURES.

FORAMINIFERA.

Genus FUSULINA, Fischer.

FUSULINA GRACILIS, Meek?

Pl. 24, Fig. 7.

Fusulina gracilis, MEEK, 1864. Paleont. of California, Vol. I, p. 4, Pl. 2, Fig. 1.

Position and locality—Roof shales of coal No. 8, Springfield, Illinois.

FUSULINA VENTRICOSA, M. and H.

Pl. 24, Fig. 8.

Fusulina cylindrica var. *ventricosa*, MEEK and HAYDEN, 1864. Paleont. of the Upper Missouri, p. 14, Pl. 1, Fig. 6.

Locality and position—Roof shales and limestone over coal No. 6, in Fulton and Peoria counties, Illinois.

RADIATA.

Genus LOPHOPHYLLUM, Edwards & Haime.

LOPHOPHYLLUM PROLIFERUM, McC. Sp.

Pl. 24, Fig. 1.

Cyathoxonia prolifera, McCHESNEY, 1860. Descr. New Pal. Foss. p. 75; also, 1865, Fig. 1, Pl. 2. Illustrations of same.

Lophophyllum proliferum, MEEK. Final Report on Nebraska, 1872, p. 144, Pl. 5, Fig. 4.

Locality and position—Very abundant in the roof shales of coal No. 8, at Springfield, Illinois, and at various other localities in the Upper Coal Measures of the State.

Genus ERISOCRINUS.

ERISOCRINUS TYPUS, M. and W.

Pl. 24, Fig. 6.

Erisocrinus typus, MEEK and WORTHEN, 1865. Amer. Jour. Sci., new series, Vol. XXXIX, p. 174; also, Report Geol. Survey of Ill., Vol. II, p. 317, Fig. 34, a, b, c.

Locality and position—Roof shales of No. 8 coal, Springfield, Ill.

Genus POTERIOCRINITES.

POTERIOCRINITES MACOUPINENSIS, Worthen Ms.

Pl. 24, Fig. 3.

BODY obconical, tapering gradually from the top of the first radials to its connection with the column; composed of smooth, slightly rounded plates, base scarcely larger than the columnar facet below, gradually widening upward, and composed of nearly equal pentagonal pieces. Subradials large, about as high as wide, two heptagonal and three hexagonal. First radials wider than high, pentagonal, and straight across their upper margins, for the reception of the second radials. First anal plate about half the size of the subradials; second anal about half as large as the first, and both pentagonal.

Arms and column unknown.

Position and locality—Upper Coal Measures; Macoupin county, Illinois.

Subgenus SCAPHIOCRINUS.

SCAPHIOCRINUS? HEMISPHERICUS, Shum. sp.

Pl. 24, Fig. 5.

Poteriocrinus hemisphericus, SHUMARD, 1858. Trans. St. Louis Acad. Sc., Vol. I, p. 221.
Scaphiocrinus? hemisphericus, MEEK, 1872. Final Report on Neb., p. 147; pl. 5. fig. 1, and pl. 7, fig. 1.

Position and locality—Upper Coal Measures; Springfield and La Salle, Illinois.

SCAPHIOCRINUS CARBONARIUS, M. and W.

Pl. 24, Fig. 2.

Poteriocrinus (Scaphiocrinus?) carbonarius, MEEK and WORTHEN, 1861. Proceed. Acad. Nat. Sci., Phila., p. 140.

BODY small, depressed or basin-shaped below the summit of the subradial plates; rounded and concave below, composed of thick, convex, smooth plates, which are connected by distinctly impressed sutures. Base small, concave, and pentagonal in outline. Subradial plates a little larger than wide, comparatively rather large, directed obliquely outward from the base, and curved upward at their extremities; all pentagonal, excepting one on the anal side, which is a little truncated at the upper extremity, for the reception of one of the anal pieces; upper angle of each rather salient. First radials nearly twice as large as the subradial pieces, wider than long, pentagonal or sub-pentagonal, the upper side being truncated, and concave in its outer slope. Second radial pieces nearly twice as long as wide, pentagonal in outline, rounded on the outer side, and distinctly constricted around the middle; supporting the first divisions of the arms upon their superior sloping sides.

Hight of body to the summit of first radials, 0.15 inch; breadth of do., 0.28 inch.

We are in some doubt in regard to the generic relations of this little species, not being acquainted with the number and arrangement of its anal plates and superior parts. It agrees with the group *Scaphiocrinus* in the number of its radial pieces. the elongated and constricted character of its second radial pieces, as well as in having the suture between the first and second radials widely gaping. It differs, however, from the typical species of that group, in having a distinctly concave base, as in *Zeacrinus*. Others, however, have referred to the genus *Scaphiocrinus* species with a concave base. There are also some appearances of an interradial piece between each two of the second radials, but we are not quite sure they are such.

Locality and position—Upper Coal Measures; Springfield, Illinois.

Subgenus ZEACRINUS.

ZEACRINUS? MUCROSPINUS, McC.

Pl. 21, Fig. 12.

Zeacrinus mucrospinus, McCHESNEY, 1859. New. Pal. Foss., p. 10; also 1865 illustrations of same, pl. 4, fig. 7, *a*, *b*.

Zeacrinus? mucrospinus, MEEK, 1872. Final Report on Nebraska, p. 149, pl. 5, fig. 2, *a*, *b*, *c*.

Position and locality—Roof shales of No. 8 coal, Springfield, Illinois; and various other localities in the upper Coal Measures of Illinois.

ZEACRINUS (HYDREIONOCRINUS?) ACANTHOPHORUS, M. and W.

Pl. 21, Fig. 11.

Zeacrinus (Hydreionocrinus?) acanthophorus, MEEK and WORTHEN, 1870. Proceed. Acad. Nat. Sci., Phila., p. 28.

BODY below the top of the first radial pieces much depressed, or nearly saucer-shaped, but concave below. Base very small, and almost entirely hidden in the concavity of the under side, when the column is attached. Subradial pieces small, four of them included in the concavity of the under side, and projecting horizontally outward into rather acute angles between the first radials, so as to present a sub-trigonal general outline, though they are really hexagonal, their lateral and inner edges being connected with each other and to the base, so as to form four very short sides, with fine, obscure angles; fifth one larger than the others, proportionally longer, and curving upward at the outer end, which is truncated, so as to form a short side for the support of one of the anal pieces. First radial pieces comparatively large, widening rapidly from below to the top, which is truncated evenly the entire breadth, and about twice as wide as the greatest hight, all curving under to connect with the subradials below in such a manner that the body rests upon them when placed upon a plane surface, with the column removed. Second radials a little smaller than the first, nearly twice as wide as long, pentagonal in form, with lateral margins short and not constricted; each supporting two arms on its superior sloping sides. Arms rather slender for species of this genus, not being wide enough to be in contact laterally all around, when raised vertically; rounded on the dorsal side, rather rapidly tapering, and, so far as can be seen in the typical specimen, all bifurcating on the second piece; below the bifurcation the two pieces are each about as long as wide, the upper one being sometimes slightly constricted around the middle; arm piece above the bifurcation rather slender, longer than wide, rounded, and distinctly constricted around the middle. First anal piece about twice as long as wide, and wedged so far down under one side of one of the first radials by the side of the largest subradial, as to come nearly or quite in contact with the very small base. Second anal small, and resting upon the short upper end of the larger subradial between the upper part of the first anal on the right and the first radial on the left; above these the alternating series continues up to connect with the ventral extension. Ventral prolongation, or so-called proboscis, about equaling the apparent length of the arms, comparatively rather narrow and sub-cylindrical below, but widening rather gradually upward above the summit, where it flares suddenly out all around to about the breadth of the body below, its top being nearly flat, or much depressed, and composed of small, unequal, convex pieces, while each one of the marginal row of these top pieces, all around, extends horizontally outward in the form of a sharp spine about two-thirds as long as the entire transverse diameter of the flattened top itself. Plates forming the sides of the ventral portion below its flattened spiniferous crown, probably more or less costated, or sculptured, in perfect examples, but the specimen seen is not in a condition to show this, though the usual pores can be seen passing through the sutures between the plates. Surface of body and arms apparently smooth.

Hight of body to top of first radials, about 0.18 inch; breadth of do., 0.65 inch; hight to top of ventral portion, including the body, 1.20 inches; breadth of the flattened top of the ventral portion, exclusive of the free marginal spines, about 0.50 inch.

The form of the body and the arrangement of the anal pieces of this species are very similar to those of our *Z. discus*, from the upper Coal Measures, but its under side is more decidedly concave, its first radial pieces proportionally higher, and separated by decidedly deeper sutures. Its subradials are also proportionally smaller. From *Z. mucrospinus*, of McChesney, it is at once distinguished by not having its second radial pieces developed into spines, and by the different structure of its arms.

The specimen here figured was found and presented to one of the authors by Mr. David Williams, of Canton, Illinois.

Locality and position—Seaville, Fulton county, Illinois; roof of Coal No. 1.

Genus EUPACHYCRINUS.

Eupachycrinus Fayettensis, Worthen Ms.

Pl. 24, Fig. 10.

Body below the top of the first radials basin-shaped, base rather deeply impressed, more than twice as wide as high, and composed of massive, slightly convex plates. Subradials considerably higher than wide, four pentagonal and one hexagonal, their upper angles extending up above the middle of the first radials, the one on the anal side giving support to a small anal piece. First radials larger than the subradials, nearly twice as wide as high, and truncated straight across their upper margins, where they give support to the second radials, with a somewhat gaping suture between. Second radials as wide as the first, and produced on their outer sides into short, rather obtuse spines. One anal piece only is seen implanted directly between the first radials, and supported by one of the subradials. Arms, so far as can be seen on the specimen under examination, composed of a series of subcuneate interlocking pieces. Surface of all the body plates below the second radials smooth.

Locality and position—Upper Coal Measures, Hickory creek, Fayette county, Illinois.

EUPACHYCRINUS TUBERCULATUS, M. and W.

Pl. 24, Fig. 9.

Erisocrinus tuberculatus, MEEK and WORTHEN, 1866. Geol. Survey of Ill., Vol. II, p. 319.

Locality and position—The detached plates from which the original description was drawn were found in the roof shales of Coal No. 6, near Brighton, Jersey county, Illinois. The more perfect specimen figured on Pl. 24 is from Parke county, Iowa.

AGASSIZOCRINUS CARBONARIUS, Worthen Ms.

Pl. 24, Fig. 4.

THIS species is only known from the anchylosed basal and subradial plates here figured, and it is the only fragment of this genus, so far as I am aware, that has been found in the Coal Measures.

Locality and position—Upper Coal Measures, Shelby county, Ill.

MOLLUSCA.

BRACHIOPODA.

Genus CHONETES, Fischer.

CHONETES ?? MILLEPUNCTATA, M. and W.

Pl. 25, Fig. 3.

Chonetes ?? millepunctata, MEEK and WORTHEN, 1870. Proceed. Acad. Nat. Sci., Phila., p. 35.

SHELL attaining a large size, very thin, transversely subsemicircular, or more than twice as wide as long, with lateral extremities rounded. Dorsal valve nearly flat, or but slightly and evenly concave; hinge line a little less than the greatest transverse diameter; cardinal process rather stout, with an obscure linear ridge (or sulcus) extending forward from its base nearly to the front; cardinal edge slightly thickened within, so as to form a faintly defined ridge extending about half way from the cardinal process toward each lateral margin, but apparently without any trace of sockets for the reception of teeth in the other valve; muscular and other internal markings unknown; surface ornamented by numerous slender, exceedingly regular, closely arranged concentric lines, exactly parallel with each other and the front and lateral margins. Ventral valve unknown.

Length of a medium sized specimen, 1.30 inches; breadth, 2.95 inches. Largest examples seen, 2.10 inches in length, and of nearly the same proportional breadth as the others.

Of this very remarkable shell, we have seen six or eight specimens, and some fragments of others. All of the specimens yet found, however, are dorsal valves only, the ventral valve being entirely unknown to us. The slightly worn, or more or less weathered condition of the specimens has obliterated whatever muscular or other internal markings there may have been. In most cases only patches of the shell itself remain, though even in these cases the general outline and external surface markings are very distinctly defined in the matrix. All the specimens show a rather obscure, linear, internal sulcus, extending from the base of the cardinal process nearly to the anterior margins. This, however, is probably caused by the accidental removal of a linear mesial ridge, because we also see it equally defined in impressions of the external surface of the valve left in the matrix, just as would be the case if a firm internal ridge had been, owing to the thickness of the shell, as it were, pressed through. The concentric lines of the surface present an extraordinary degree of regularity, both in size and arrangement. On a medium sized dorsal valve about sixty of these lines may be counted, while some of the largest show twice as many. They are of exactly the same size and distance apart on all the specimens, and of so nearly the same size on all parts of the same individual, as to appear to the eye to be exactly uniform throughout. By measurement, however, we count fifteen of them in the space of 0.25 inch, near the margins of a medium sized specimen, and twenty in the same space near the beak. In a few instances we have observed what seemed to be the faintest possible traces of a few larger radiating lines of costæ near the middle of the anterior margin of the dorsal valve. None of the specimens show the cardinal process entire, but as far as its characters can be made out, it seems to have been much as in *Chonetes*.

The most remarkable character of this shell, however, remains to be noticed. That is, its extremely coarse punctate structure, and the unusually close arrangement of the punctures, which are so large as to be nearly visible to the unassisted eye. As seen by the aid of a common single pocket lens, they present on the inner surface of the dorsal valve much the appearance and arrangement of the cells of a delicate *Chætetes*, the spaces between them being much less than the diameter of the pores themselves. They appear to diminish rapidly in size, however, as they approach the external surface, near which they seem to be a little less than the diameter of the spaces by which they are separated. As we have never seen such a shell structure as this in any species known to possess the characters of the genus *Chonetes*, nor indeed to any other known Brachiopod, we are very strongly inclined to believe our shell really belongs to an undescribed genus. The fact that there appears to be no sockets in the cardinal margins of its dorsal valve for the reception of teeth in the other valve, would also favor the conclusion that it is not a true *Chonetes*. Nevertheless, we prefer to place it, provisionally, in that genus, until specimens can be obtained showing the dorsal valve, with the muscular impressions and other generic characters. Should it be found, as we believe it will, to be a new generic type, we would suggest for it the name *Isogramma* (ἴσος, equal; γραμμή, a line), in allusion to the remarkable equality of the concentric lines of the surface.

To whatever genus our shell may really belong, it is evidently very closely allied, even specifically, to a form figured by Mr. DAVIDSON, from the Carboniferous Limestone of Scotland, in his valuable Monograph of the British Carboniferous Brachiopoda, Vol. II, Part V, pl. 55, fig. 13. Mr. DAVIDSON referred his shell, with much doubt, on the authority of Dr. DE KONINCK, to *Chonetes concentrica*, of the latter author. We fully concur with Mr. DAVIDSON, however, in the opinion that it is distinct from Prof. DE KONINCK'S species,* as it is much longer, and instead of being marked with only twelve to thirteen large concentric ridges, has about thirty-seven regular, more concentric lines. In our species there are about twice the number of lines seen on that figured by Mr. DAVIDSON, in specimens of the same size; and as this character is remarkably uniform in all our specimens, we cannot believe it otherwise than a specific difference.

Locality and position—Upper Coal Measures; Marion county, Illinois, where it occurs associated with nearly all the fossils in the upper Coal Measures of Kansas and Iowa, and in those in Nebraska referred by Professors MARCOU and GEINITZ to the Permian.

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* It is due to Professor DE KONINCK that we should state that it was only doubtfully he referred the English specimen to his species

Genus PRODUCTUS, Sowerby.

PRODUCTUS NEBRASCENSIS, Owen.

Pl. 25, Fig. 8.

Productus Nebrascensis, OWEN, 1852. Geol. Report Wis., Iowa and Minn., p. 584, Pl. 5, Fig. 3; 1867, MCCHESNEY, Trans. Acad. Sci., Vol. I, p. 24, Pl. 1, Fig. 7.
Syn. *P. Rogersii*, NORWOOD and PRATTEN. Jour. Acad. Nat. Sci., Phila., Vol. III, new series, p. 9, Pl. 1, Fig. 3, a, b. c.
P. asper, MCCHESNEY, 1860. Desc. new Paleozoic Fossils, p. 34.

Locality and position—Coal Measures, Sangamon and La Salle counties, Illinois.

PRODUCTUS LONGISPINUS, Sowerby?

Pl. 25, Fig. 10.

Productus longispinus, SOWERBY, 1814. Min. Conch , Vol. I, p. 154, Pl. LXVIII, Fig. 1.
P. Wabashensis, NORWOOD and PRATTEN, 1854. Jour. Acad. Nat. Sci., Phila., Vol. III, new series, p. 13, Pl. 1, Fig. 6.
P. splendens, of same authors, 1854. Jour. Acad. Nat. Sci., Phila., Vol. III, new series, p. 11, Pl. 1, Fig. 5.

Locality and position—Abundant throughout the Upper and Lower Coal Measures of Illinois.

PRODUCTUS PUNCTATUS, Martin.

Pl. 25, Fig. 13.

Productus punctatus, MARTIN, 1809. Petref. Derb. Pl. XXXVII, Fig. 6.
P. tubulospinus, MCCHESNEY, 1860. Descrip. New Pal. Foss., p. 37.

Locality and position—Upper and Lower Coal Measures of Illinois.

PRODUCTUS LASALLENSIS, Worthen Ms.

Pl. 25, Fig. 9.

THIS shell resembles the one usually referred to *P. costatus*, of Sowerby, but differs from that form in having a narrower and deeper sinus, which extends to the beak; ears more produced, with only two or three slender spines on their margins; costæ more even on the front portion of the shell, the spines less numerous and more slender, and without concentric wrinkles. The dorsal valve is concave in the visceral region, nearly quadrangular in outline, the front slightly sinuous, and sharply recurved on the margin, reniform processes smaller than in *P. costatus*, more elevated, and nearer the hinge line. Cardinal process trilobed.

Locality and position—Upper Coal Measures, La Salle, Illinois.

CHONETES SMITHII, N. and P.

Pl. 25, Fig. 11.

Chonetes Smithii, NORWOOD and PRATTEN, 1855. Jour. Acad. Nat. Sci., Phila., Vol. III, new ser., p. 24; pl. 2, fig. 2, *a*, *b*, *c*.

Position and locality—Roof of Belleville coal; St. Clair county, Illinois.

Genus HEMIPRONITES, Pander.

HEMIPRONITES CRASSUS, M. and H.

Pl. 25, Fig. 12.

Orthisina crassa, MEEK and HAYDEN, 1858. Proceed. Acad Nat. Sc., Phila., p. 260
Orthis Lasallensis, 1860, MCCHESNEY. New Pal. Foss., p. 32, pl. I, fig. 6, *a*, *b*.
O. Richmondi, MCCHESNEY. Ib., fig. 5, *a*, *b*, *c*.
Hemipronites crassus, MEEK and HAYDEN, 1864. Paleont. Upper Missouri, p. 26, fig. 7, *a*, *b*, *c*, *d*.

Position and locality—Abundant in upper Coal Measures; La Salle, Illinois.

Genus ATHYRIS, McCoy.

ATHYRIS SUBTILITA, Hall's (sp.)

Pl. 25, Fig. 14.

Terebratula subtilita, HALL. Stansbury's Grt. Salt Lake Report, p. 409, pl. IV, fig 1, *a*, *b*, and 2, *a*, *b*.
Spirigera subtilita, MEEK and HAYDEN, 1859. Proceed. Phila. Acad. Nat. Sci., p. 20, etc.
Athyris subtilita, NEWBERRY, 1861. Ives' Colorado Report, p. 126.

Position and locality—Abundant throughout the Coal Measures.

Genus SYNTRIELASMA, M. and W.

SYNTRIELASMA HEMIPLICATA, Hall's sp.

Pl. 26. Fig. 20.

Spirifer hemiplicata, HALL, 1852. Stansbury's Salt Lake Report, p. 409; pl. 4. fig. 3.
Syntrielasma hemiplicata, MEEK and WORTHEN, 1866. Report Geol. Survey of Ill., Vol. II, p. 323; fig. 36, and p. 324, fig. 27,

Position and locality—Upper Coal Measures; twelve miles north of Vandalia, Fayette county, Illinois.

Genus MEEKELLA, White and St. John.

MEEKELLA STRIATO-COSTATA, Cox sp.

Pl. 26. Fig. 21.

Plicatula striato costata, COX, 1857. Owen's Geol Report of Ky., Vol. III, p. 568, pl. 8, fig. 7.
Meekella striato-costata, WHITE and ST. JOHN, 1867. Trans. Chicago Acad. Sci., Vol. I, pp. 120, 122; figs. 4, 5 and 6.

Position and locality—La Salle, Caseyville and various other localities in Illinois; in upper and lower Coal Measures.

Genus RHYNCHONELLA, Fischer.

RHYNCHONELLA OSAGENSIS, Swallow.

Pl. 26. Fig. 22

Rhynchonella (Camarophoria) Osagensis, SWALLOW, 1858. Trans. St. Louis Acad. Sc., Vol. I, p. 219.
Terebratula Uta, MARCOU, 1858. Geol. N. Am., p. 51; pl. 6, fig. 12.

Position and locality—Coal Measures, Danville, Illinois; and roof of Coal No. 6, Fulton county, Illinois.

Genus ORTHIS, Dalman.

ORTHIS CARBONARIA, Swallow.

Pl. 25, Fig 4.

Orthis carbonaria, SWALLOW. Trans. St. Louis Acad. Sci., Vol. I, p. 218.

Position and locality—Upper Coal Measures; La Salle, Illinois.

Genus TEREBRATULA, Llhwyd.

TEREBRATULA BOVIDENS, Morton.

Pl. 25, Fig. 15.

Terebratula bovidens, MORTON, 1836. Am. Jour. Sci., Vol. XXIX, p. 150.
T. geniculosa, MCCHESNEY, 1861. Descr. New. Pal. Foss., p. 82. Also, 1865 illustrations of same; pl. 1, fig. 2, *a*, *b*, *c*.

Position and locality—Upper and lower Coal Measures of Illinois.

Genus DISCINA, Lamark, 1819.

DISCINA NITIDA, Phillips sp?

Pl. 25, Fig. 1.

Orbicula nitida, PHILLIPS. Geol. of York, Vol. II, p. 221; pl. 11; figs. 10-13.
Syn. Discina Missouriensis, SHUMARD. Trans. St. Louis Acad. Sci., 1860, p. 221.

Specimens of this shell sent to Prof. DAVIDSON were pronounced by him identical with the European form known as *D. nitida*.

Position and locality—Common throughout the Coal Measures of Illinois.

Genus LINGULA, Bruguiere, 1789.

LINGULA MYTILOIDES, Sowerby?

Pl 25. Fig. 2.

Lingula mytiloides, SOWERBY. Min. Con., Tab. XIX; figs. 1 and 2, 1813.
Compare L. umbonata, COX. Geol. Survey of Kentucky, Vol. III, p. 576; pl. 10, fig. 4.

Position and locality—Common throughout the Coal Measures of Illinois.

SPIRIFER FULTONENSIS, Worthen Ms.

Pl. 25, Fig. 5.

SHELL rather small, transversely oval, valves nearly equal in convexity, with a wide cardinal area restricted entirely to the ventral valve, and divided by a triangular fissure. Hinge line equal to the greatest width of the shell, cardinal angles not rounded. Dorsal valve moderately convex, mesial fold extending to the beak, and divided along the middle by a shallow, longitudinal depression. Dorsal valve rather deeper than the ventral, the beak extending considerably beyond that of the opposite valve; sinus deep, extending from the beak to the opposite margin, with a single rounded plication in the center. Surface ornamented with sixteen to twenty smoothly rounded plications on each valve, nearly twice as wide as the spaces between them.

Of this unique little shell we have seen but a single specimen, which was found by Mr. JOHN WOLF, of Canton, in the limestone over one of the coal seams outcropping at that point.

Position and locality—Lower Coal Measures; Fulton county, Illinois.

SPIRIFER CAMERATUS, Morton.

Pl. 25, Fig. 7.

Spirifer cameratus, MORTON. Am. Jour. Sci., Vol. XXIX, p. 150; pl. 2, fig. 3.

Position and locality—Common throughout the Coal Measures of Illinois.

LAMELLIBRANCHIATA.

Genus MONOTIS.

MONOTIS? GREGARIA, M. and W.

Pl. 26, Fig. 5.

Monotis? gregaria, MEEK and WORTHEN, 1870. Proceed. Acad Nat. Sci., Phila., p. 38.

SHELL very small, extremely thin, compressed, oblique, varying from truncato-suboval to subcircular; hinge line less than the breadth of the valves; auricles small, obtusely angular, undefined by any sinuosity of the margins; posterior(?) margin rather regularly rounded in outline, and rounding into the pallial margin; anterior(?) border prominent below, and rounding into the base, but straight and ascending with a backward slant to the hinge; beaks located near the middle of the hinge line, above which they seem scarcely to rise. Surface marked by extremely fine concentric striæ, and a few somewhat larger furrows or wrinkles of growth, crossed on the anterior (?) half of each valve by small radiating costæ, generally not defined near the anterior (?) margin. Antero-posterior diameter 0.25 inch; hight, or diameter at right angles to the hinge, 0.20 inch; convexity unknown.

Of this litttle shell we have numerous specimens, all compressed to entire flatness on the surfaces of the laminæ of shale, many of them lying with the two valves opened out and connected by their hinge margins. As thus seen their small size causes them to appear much like the valves of *Posidonomia*, or those of some of the little phyllopod Crustacea. This form, however, is found on closer examination to be different, while their radiating costæ also indicate different affinities. Some individuals are a little wider proportionally, in their antero-posterior diameter, than that from which the above measurements were taken, and these have much the outline of the left valve of some forms of *Aviculopecten*, excepting that the auricles are not in the slightest degree defined (in either valve) by any traces of a marginal sinus.

It is possible that this little shell may be a true *Lima*, as it has much the form of some species of that genus, and there certainly are in the Western Coal Measures two or more species apparently agreeing in all respects with that genus. If a *Lima*, of course the side we have described as the anterior must be the posterior, and *vice versa*. The reasons for doubting its relations to the genus *Lima*, however, are (1), extreme thinness; (2), the fact that it seems to have a prismatic structure; and (3), its very small size. It is possible, however, that the extremely thin, fibrous shell, as we now see, may consist only of the external lamina, left after the decomposition of the inner layers. If so, and the fibrous appearance is really the original structure, it would more probably belong to some perhaps undescribed genus, allied to *Aviculopecten*, of the family *Aviculidæ*. If a true *Monotis*, it would be the only known species of that genus in our Carboniferous rocks, the common Western Coal Measure shells usually referred to that genus belonging to a very distinct group, to which BEYRICH has applied the name *Pseudomonotis*.

Locality and position—Jacksonville coal shaft, roof of coal No. 3 ? of the Illinois section, Jacksonville, Illinois.

Genus MACRODON, Lycett.

MACRODON DELICATUS, M. and W.

Pl. 26, Fig. 3.

Macrodon delicatus. MEEK and WORTHEN, 1870. Proceed. Acad. Natural Sci., Phila., p. 40.

SHELL small, about twice and a-half as long as high, moderately convex, elongate rhomboidal in outline, posterior margin obliquely truncated, so as to be angular at the base; cardinal margin about three-fourths the entire length, and nearly parallel with the base; anterior extremity very narrowly rounded; basal margin nearly straight along the middle, but rounding very gradually upward anteriorly; beaks depressed, and placed about one-fourth the entire length of the valves behind the anterior extremity; posterior umbonal slopes subangular from the beaks obliquely backward and downward, to the sharply rounded or subangular posterior basal extremity, while the spaces behind and above these slopes are compressed or slightly concave. Surface marked by small ridges and lines of growth, which are crossed by raised radiating lines or linear costæ, rather widely separated posteriorly, but more closely arranged, and less strongly defined towards the front part of the valves. (Cardinal area, hinge and muscular impressions unknown.) Length 0.45 inch; hight, 0.19 inch; convexity about 0.11 inch.

This little shell will be readily distinguished from its associate, formerly described by us under the name *M. tenuistriatus*, by its much more oblique and less gibbous form; but more especially by having its linear radiating costæ separated by wide intervening spaces, instead of being closely crowded together. We know of no species with which it could be confounded.

Locality and position—Springfield, Illinois. Upper Coal Measures.

MACRODON TENUISTRIATUS, M. and W.

Pl. 26, Fig. 4.

Macrodon tenuistriata, MEEK and WORTHEN, 1867. Proceed. Chicago Acad. Sci., Vol. I, p. 17.

SHELL small, rhombic-oblong, rather distinctly convex along the umbonal slopes, and near the front a little more than twice as long as high; basal and cardinal margins parallel, the former nearly straight, or somewhat sinuous near the middle; cardinal margin straight, not quite equaling the greatest antero-posterior diameter; anterior side rounding up from below, so as to meet the hinge nearly at right angles; posterior basal margin narrowly rounded; posterior margin obliquely truncated, often a little sinuous above, dorsal region behind the umbonal slope compressed; beaks convex, a little flattened, incurved, rising somewhat above the hinge margin, located about half way between the middle and the front; flanks broadly impressed or concave from the umbonal regions obliquely backward to the faintly sinuous part of the base; cardinal area unknown; posterior linear teeth about three; surface ornamented with distinct marks of growth, crossed by radiating markings, which, on the compressed posterior dorsal region, form rather well defined, radiating lines; anteriorly, however, these diminish in size, so as to become very minute or scarcely visible, crowded, obsolescent striæ.

Length, 0.75 inch; hight, 0.31 inch; convexity, about 0.30 inch.

Position and locality—Upper Coal Measures; Springfield, Illinois.

Genus AVICULA.

AVICULA MORGANENSIS, M. and W.

Pl. 26, Fig. 14.

Pteria (Pterinea) Morganensis, MEEK and WORTHEN, 1866. Proceed. Acad. Nat. Sci., Phila., p. 259.

SHELL (left valve), exclusive of the posterior wing, obliquely sub-ovate, moderately convex, very thin; anterior and basal margins forming an obliquely descending semi-oval or semicircular curve from the anterior ear to the posterior margin, which is prominently and rather narrowly rounded; hinge line somewhat less than the length of the shell, and ranging at an angle of about forty-five degrees above a line drawn from the beak to the most prominent part of the posterior basal margin; beak oblique, rather convex, and placed very nearly over the anterior extremity of the hinge; anterior ear very small, a little convex, but separated from the swell of the umbo by an oblique, shallow, rounded sulcus or impression, rounded at the extremity, and defined in outline by a very shallow marginal sinuosity; posterior wing large, flattened, triangular, and defined in outline by a broad, moderately deep, rounded sinus, not equaling in length the most prominent part of the posterior margin below the sinus; in young shells rather acutely angular, but more obtuse in adult specimens. Surface ornamented by numerous linear, radiating costæ, smaller than the flattened spaces between, and crossed by raised concentric lines, so as to form a neat cancellated style of marking, quite as distinct on the posterior wing as on the body of the valve; radiating costæ increasing by intercalation, the intermediate ones dying out at various distances between the free margin and the beak, all more or less interrupted at various intervals by irregular, shallow concentric furrows of growth. (Right valve unknown.)

Length of the largest specimen, measuring obliquely from the most prominent part of the posterior basal margin to the extremity of the small anterior ear, 1.55 inches; do., parallel to the hinge line, 1.41 inches; hight at right angles to the hinge, 2 inches; length of hinge and anterior ear, 1.17 inches; length of posterior ear, from the beak to its extremity, 0.91 inch.

This rather handsome species has more the aspect of certain Upper Silurian forms, such as *Avicula communis*, Hall, than of any other Carboniferous species with which we are acquainted, though of course presenting well marked specific differences. All of the twenty-odd specimens we have seen are left valves, from which fact we may infer that the right valve was more fragile, and consequently rarely preserved. It is also probable that it was less convex, and more faintly marked than the other, as is usual in shells of this kind. As we know nothing of the hinge and muscular impression of this shell, we of course cannot determine whether it is a *Pterinea* or a true *Pteria (=Avicula)*. If the latter, and KLEIN'S older pre-Linnæan names are to be adopted, its name will become *Avicula Morganensis*.

Locality and position—Below the middle of the Coal Measures; Morgan county, Illinois.

AVICULA LONGA, Geinitz sp.

Pl. 26 Fig. 1.

Gervillia longa, GEINITZ, 1866. Carb. and Dyas in Nebraska, p. 32, taf. 2, fig. 15.

Locality and position—Danville, Illinois; roof shales of Coal No. 7.

Genus PLACUNOPSIS.

PLACUNOPSIS CARBONARIA, M. and W

Pl. 27 Fig. 2.

Placunopsis carbonaria, MEEK and WORTHEN, 1866. Proceed. Chicago Acad. Sci., Vol. I, p. 13.

SHELL orbicular, compressed sub-hemispherical, extremely thin. Upper or right valve irregularly convex, sometimes rather gibbous; hinge margin straight, generally equaling about one-third to one-half the diameter of the valves, and usually showing a slight disposition to develope small, obtuse ears at the extremities; beak very small, sometimes compressed and nearly obsolete, marginal, but not projecting distinctly beyond the cardinal border, located at the middle of the hinge, and showing a slight forward curvature. Under valve flat, or conforming to the inequalities of the surface to which it was attached; beak marginal, and very nearly obsolete. Surface of both valves marked with irregular, undulating or interrupted radiating lines, with broad, faint, irregular concentric wrinkles, and a set of obscure striæ of growth. Often there is also an entirely independent series of parallel ridges, crossing the umbonal region, or sometimes the whole surface obliquely, and partly, or sometimes almost entirely, obliterating the other markings. (Hinge and interior unknown.)

Diameter of the largest specimen found, from the hinge to the pallial margin, 1.30 inches; oblique parallel ridges uniformly numbering seven to eight in 0.20 inch.

Although the species upon which the genus *Placunopsis* was founded was from the Great Oolite, and we have no knowledge of the genus having ever been identified from older rocks, our specimens agree so exactly in all their visible characters with the figures and description of that group, that we can scarcely doubt the propriety of referring our species to it. Indeed, if it were not for the curious parallel, oblique markings seen on most of the specimens, it might even be confounded with the typical species of the genus (*P. Jurensis*, of Rœmer); and if we are not mistaken, one of MORRIS and LYCETT'S figures shows some traces of similar markings, though they cross the valves obliquely in the opposite direction.

On some of the specimens we observe small discs growing, which we should think probably the under valve of the young of the shell under consideration, were it not that the minute apex of each is sub-central, while the beak of our shell seems to have been marginal at all stages of growth.

We know of no other shell from any of our palæozoic rocks with which this is liable to be confounded.

Locality and position—Springfield, Illinois; upper part of the Coal Measures.

Genus SCHIZODUS, King.

SCHIZODUS AMPLUS, M. and W.

Pl. 27, Fig. 6.

Schizodus amplus, MEEK and WORTHEN, 1870. Proceed. Acad. Nat. Sci., Phila., p. 41.

SHELL attaining a large size, as determined from internal casts, moderately convex, oblong-suboval in outline, or about one-fourth of its length longer than high; anterior side short, rounding from above the middle into the base; outline of ventral margin forming a broad semi-ovate curve; posterior margin nearly vertically subtruncated, but rounding abruptly into the dorsal margin above and into the base below; cardinal border nearly straight, and sloping very slightly from the beaks posteriorly; beaks much depressed, nearly anterior, incurved, closely approximated, and directed forward and inward. Posterior abductor muscular scar shallow, rather large, suboval, and located close up under the posterior extremity of the hinge; anterior do., smaller, deeper, subovate, and placed very near the anterior margin a little above the middle, with rather distinct, nearly detached pedal muscular scars at their upper ends. Posterior umbonal slopes with each a distinct sulcus extending from the beaks obliquely backward and downward, becoming wider and more shallow as they descend, so as to die out before reaching the posterior basal margin. (External surface unknown.) Length of cast, 2.60 inches; hight of do., 2.15 inches; convexity, 1.56 inches.

This is the largest species of *Schizodus* (if it belongs to that genus) we have yet seen. Our only specimen is an internal cast, giving no idea of the nature of the hinge. From its general appearance, however, and the nature of its muscular and simple pallial scars, together with the remains of its external ligament, we can have little doubt in regard to its being a *Schizodus*. In size and general outline its internal cast closely resembles *Amphicœlia Leidyi*, described by Prof. HALL, from the Upper Silurian Limestone at Bridgeport, near Chicago. It has, however, obviously no near relations to that shell. For a *Schizodus* its beaks are unusually depressed and oblique. We know of no other species resembling it in general form.

Compared with *Schizodus occidentalis (Cypricardia? occidentalis,* Swallow,*)* which seems to be a true *Schizodus*, and agrees with our shell in size, it is at once distinguished by its much more depressed beaks, less convex valves, and broadly round posterior outline. Prof. SWALLOW'S species also occurs in our Coal Measures, but we have only yet seen it from a higher part of the series at La Salle.

Position and locality—Seaville, Fulton county, Illinois; roof of coal No. 1.

SCHIZODUS (PRISCONIA) PERELEGANS, M. and W.

Pl. 26, Fig. 19.

Schizodus (Prisconia) perelegans, MEEK and WORTHEN, 1870. Proceed. Acad. Nat. Sci., Phila., p. 42.

SHELL attaining a moderately large size, ovate-subcordate in general form, very gibbous, apparently closed all around, rather thin. Anterior and posterior views presenting a neat cordate outline. Pallial margin semi-ovate, the most prominent part being in front of the middle; anterior side very short, and rounding up abruptly from below; posterior side narrowly rounded or subangular; hinge line apparently rather short; beaks very gibbous, prominent, pointed, and strongly incurved, so as to bring their points nearly or quite in contact; located near the anterior margin; lunule excavated, but not distinctly defined. Surface appearing to the unassisted eye almost smooth, excepting very regular raised concentric striæ, or small costæ, on the anterior part of the valves, with obscure traces of smaller striæ crossing the same. Under the highest power, however, that can be well used as a hand magnifier, the whole surface is seen to be covered by an extremely minute, perfectly regular, crowded sculpturing, as if made by crowded, microscopic cross-lines, entirely invisible even under a good common pocket magnifier.

Hight of a small specimen, 0.90 inch; convexity of same, 0.80 inch; length, about 1.18 inches. Other imperfect specimens show that the species sometimes attained three or four times the size of that from which the above measurements were taken.

Position and locality—Roof of the Danville coal, No. 7 of the Illinois section, near Danville, Illinois. We are indebted to Dr. J. C. WINSLOW, of Danville, for the specimen described.

SCHIZODUS CURTUS, M. and W.

Pl. 26, Fig. 16.

Schizodus curtus, MEEK and WORTHEN, 1866. Proceed. Chicago Acad. Sci. Vol. I, p. 18.

SHELL small, sub-orbicular, rather compressed, thin; anterior side obliquely truncated, with a convex outline above, and rounded into the base below; base deeply rounded anteriorly, and ascending with a slightly straightened outline, or even sometimes very faintly sinuous behind; posterior side narrower than the front, nearly vertically truncated, so as to form almost a right angle with the base at the termination of the umbonal ridge, and more or less rounded into the cardinal margin above; posterior dorsal region behind the umbonal ridge compressed and cuneate; cardinal margin sloping more or less behind the beaks; beaks elevated, incurved, and placed very slightly in advance of the middle; umbonal slope rather distinctly angular from the beaks to the posterior basal extremity; flanks just in advance of this ridge sometimes faintly concave; surface marked with very fine concentric striæ.

Length of the largest specimen from which the above description was drawn up, 0.43 inch; hight, 0.33 inch; convexity, about 0.16 inch.

Locality and position—Wabash cut-off near New Harmony, Indiana, and in the nodules of argillaceous limestone over Coal No. 4, in Fulton county, Illinois.

Genus MYALINA, de Koninck.

MYALINA PERATTENUATA, M. and H.

Pl. 26, Fig. 11.

Myalina perattenuata, MEEK and HAYDEN, 1858. Trans. Albany Institute.

Position and locality—This shell is abundant in a blue shale below Coal No. 7, in the shafts at Springfield, Illinois.

Genus EDMONDIA.

EDMONDIA? PEROBLONGA, M. and W.

Pl. 27, Fig. 4.

Edmondia? peroblonga, MEEK and WORTHEN, 1866. Proceed. Acad. Nat. Sci., Phila., (for Dec. 1865,) p. 249.

SHELL longitudinally oblong, the length being about double the hight, very inequilateral, moderately convex; the greatest convexity being along the oblique umbonal slopes, above and below which the valves are cuneate postero-dorsally and antero-ventrally. Posterior side distinctly compressed near the extremity, its margin somewhat rounded or sub-truncate in outline; anterior side very short, less compressed and rather more narrowly rounded than the other; basal and dorsal margins nearly straight and parallel, the former being very slightly convex in outline a little in advance of the middle. Beaks near the anterior end, very oblique, compressed, and but slightly elevated above the hinge margin; umbonal slopes prominently rounded or sub-angular from the beaks obliquely towards the posterior inferior margin. Surface of cast showing only faint traces of a few irregular concentric undulations, mainly below the umbonal ridge. (Hinge and interior unknown.)

Length, 2.50 inches; hight, 1.25 inches; convexity of a left valve, 0.47 inch.

Although the only specimen of this species we have seen is merely a cast, showing nothing of the hinge, or the internal characters, nor of the finer surface markings, we have thought it desirable to call attention to it as one of the bivalves of this horizon, as it will probably be long before better examples are found. We confess, however, that we are at a loss in regard to its generic characters, and have merely placed it provisionally in the genus *Edmondia*.

In general appearance, this shell approaches *Edmondia? compressa* of McCoy, (Carb. Foss. Ireland, pl. 13, fig. 10,) but it is rather longer in proportion to its hight, and it has much less prominent and more compressed beaks, as well as sub-angular, instead of obtusely rounded umbonal slopes.

Position and locality—La Salle, Illinois; Silicious Limestone of the upper division of the Coal Measures.

Genus CLINOPISTHA, M. and W.

CLINOPISTHA RADIATA, VAR. LEVIS, M. and W.

Pl. 27, Fig 7.

Clinopistha radiata, var. levis, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1870, p. 44.
Edmondia radiata, HALL, 1858. Iowa Geol. Report, Vol. I, Part 2, p. 716; Pl. 29, Fig. 3.

SHELL oval, approaching oblong, the hight being from two-thirds to three-fourths the length, moderately convex in young examples, and becoming ventricose with age; anterior side much longer and wider than the others, regularly rounded in outline; posterior side very short, rather narrow below the beaks, and vertically truncated; ventral margin most convex a little in advance of the middle, thence round upward into the front, while behind the middle, or nearly under the beaks, it is slightly contracted or sinuous; dorsal outline sub-parallel to the base, the margins of the valves being erect anteriorly and rounding into the anterior margin; hinge line rather short; beaks rather ventricose, rising above the hinge line and placed about half way between the middle and posterior end; posterior umbonal slopes often rendered somewhat prominently rounded by a slight flattening of the valves behind the beaks, near the truncated margin; ligament lance-oval in form, rather short, and placed immediately behind the beaks, exactly in the position we would expect to see the lunule if the shorter side of the valve were the anterior; surface with a polished appearance, and generally only showing fine lines of growth, but in some examples also having obscure radiating marks near the ventral margin, which are nearly always defined on internal casts.

Length of a large specimen, 1 inch; hight, 0.62 inch; convexity, 0.51 inch.

Locality and position—Roof of Coals Nos. 4 and 5 of the Illinois section, in Fulton county, and in the shafts at Springfield.

Genus ALLORISMA, King.

ALLORISMA COSTATA, M. and W.

Pl. 26, Fig. 15.

Allorisma costata, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1869, p. 171.

SHELL under medium size, longitudinally oblong, the length being more than twice the hight, very thin, rather convex in the central umbonal regions; anterior margin rather short, closed, and narrowly rounded; basal margin forming a long, nearly semi-elliptic curve, with a very slight sinuosity in front of the middle; posterior side compressed, but apparently a little gaping and distinctly truncated nearly vertically from the base about half way up, and thence a little obliquely forward and upward to the dorsal margin; posterior dorsal region compressed above the umbonal ridge; cardinal margin equaling about two-thirds the entire length of the shell, very nearly straight, and inflected so as to form a narrow or lance-linear corselet, extending its whole length; beaks convex, rising a little above the cardinal margin, and placed slightly more than one-sixth the length of the valves behind the anterior extremity; lunule well defined and lance-ovate in form. Surface ornamented by about twenty-five very regularly arranged, distinctly elevated, concentric costæ, which commence near the lunule and extend backward parallel to the base, to the well defined, angular umbonal ridge leading from the beaks to the posterior basal extremity, at which ridge they become suddenly obsolete, or very nearly so, being mainly represented on the more compressed posterior dorsal region by distinct lines of growth, which are crossed on the middle of this area by a second oblique linear ridge extending from the beaks to the middle of the posterior margin. Some indications of the usual minute surface granules appear to be visible in some of the moulds left in the matrix.

Length, about 1.20 inch; hight, 0.53 inch; convexity, 0.44 inch.

This is a very neat, elegant species, of the type *A. elegans*, King, and *A. Geinitzii*, Meek. It is a more slender species, however, with much more sharply elevated and more regularly disposed costæ than the former; while it will also be readily distinguished from the latter by its costæ, and much more depressed umbones, wider (higher) posterior extremety, etc. The regularity and prominence of its concentric costæ, and their very abrupt termination along the umbonal ridge or carina, are remarkable characters that give the posterior half of the valves much the appearance of some types of *Trigonia*.

Locality and position—Found by Mr. GREEN, of the Illinois Survey, in Warren county, Illinois, in a black, bituminous limestone near the base of the Coal Measures.

ALLORISMA GEINITZII, Meek.

Pl. 26, Fig. 23.

Allorisma elegans, GEINITZ, 1866. Carb. und Dyas in Neb. p. 43; Tab. 4, fig. 21. (Not of King, 1844.)
Allorisma Geinitzii, MEEK, 1867. Am. Jour. Sci. and Arts, Vol. 44, n. s., p. 170.

Position and locality—Roof shales of Coal No. 3; Knox county, Illinois.

Genus CHÆNOCARDIA, M. and W.

CHÆNOCARDIA OVATA, M. and W.

Pl. 27, Fig. 5.

Chænocardia ovata, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1860, p. 170

SHELL obliquely ovate, more than two-thirds as wide as long, moderately gibbous, the greatest convexity being a little in front of the middle. Posterior outline rounding into the cardinal margin above, and into the base with a broad sub-semicircular curve; deepest part of the base behind the middle, from near which the anterior ventral margin ascends very abruptly and a little obliquely forward, with a slightly convex outline, to the lower part of the anterior hiatus. Anterior gaping edge truncated, with a slightly convex outline and forward slope from immediately in front of the beaks, and defined, or separated from the body of the shell by a faint sulcus, starting from the immediate front of the beak, and curving downward so as to intersect the margin at the base of the hiatus, which (supposing it to be equally developed in the right valve) is about twice as long as wide, and of a broad, lance-ovate form, most angular at the base. Hinge line scarcely more than one-fourth the greatest length of the shell, measuring obliquely from the the anterior extremity to the posterior basal margin, and ranging at an angle of about forty five degrees to the longer axis of the valves. Beaks very small, incurved, and depressed almost to the cardinal margin; located nearly over the anterior edge. Surface with concentric striæ obscure; radiating costæ of the posterior dorsal region very faintly marked, and broader than the slight furrows between, while very obscure traces of fine longitudinal striæ may be seen on some of them; radiating costæ of the anterior fine, and rather sharply defined on the gaping edge, back of which a few larger, obscure ribs may be seen, the posterior one of which is larger than the others, and curves down from the anterior side of the beak so as to intersect the margin of the valve a little below the lower end of the hiatus.

Length, 2 inches; breadth, measuring at right angles to the greatest length, 1.48 inch; convexity of the left valve, 0.50 inch; length of anterior hiatus, 0.63 inch; breadth of do. in same, 0.16 inch.

This shell differs so widely from all others known to us from our Carboniferous rocks, that a comparison is unnecessary. Indeed, we know of no other form liable to be confounded with it, from rocks of any age.

Locality and position—Waupecan creek, Grundy county, Illinois; from the lower part of the Coal Measures.

Genus CHÆNOMYA, M. and H.

CHÆNOMYA MINNEHAHA, Swallow sp.

Pl. 27, Fig. 3.

Allorisma? Minnehaha, SWALLOW, 1858. Trans. St. Louis Acad. Sci., Vol. I, p. 193.
Chænomya Minnehaha, MEEK and HAYDEN, 1858. Pal. Up. Mo., p. 43.

Position and locality—Upper Coal Measures; Clinton county, Illinois.

Genus CARDIOMORPHA.

CARDIOMORPHA MISSOURIENSIS, Shum.

Pl. 27, Fig. 8.

Cardiomorpha Missouriensis, SHUMARD. Trans. St. Louis Acad. Sci., 1860. Vol. I, p. 207.

Position and locality—Abundant in roof shales and limestone over Coal No. 3; Colchester, Illinois.

Genus ENTOLIUM, Meek.

ENTOLIUM AVICULATUM, Swallow sp.

Pl. 26, Fig. 12.

Pecten aviculatus, SWALLOW, 1858. Trans. St. Louis Acad. Sci., Vol. I, p. 215.
Entolium aviculatum, MEEK. Final Report on Neb., p. 189; pl. 9, fig. 11, *a–f*.

Genus LIMA, Bruguiere.

LIMA RETIFERA, Shum.

Pl. 26, Fig 2.

Lima retifera, SHUMARD, 1858. Trans. St. Louis Acad. Sci., Vol. I, p. 214.

Position and locality—Coal Measures, Springfield, and various other localities in Illinois, in both upper and lower coals.

AVICULOPECTEN NEGLECTUS, Geinitz sp.

Pl. 26, Fig. 7.

Pecten neglectus, GEINITZ, 1866. Carb. und Dyas in Neb., p. 33; tab. 2, fig. 17.
Aviculopecten neglectus, MEEK, 1867. Am. Jour. Sci. and Arts, Vol. 45, p. 64.

Position and locality—Upper and lower Coal Measures of Illinois.

Genus PLEUROPHORUS, King.

PLEUROPHORUS OBLONGUS, Meek?

Pl. 26, Fig. 6

Pleurophorus oblongus, MEEK, 1872. Final Report on Nebraska, p. 212.

Locality and position—Upper Coal Measures; Springfield, Illinois.

Genus NUCULA, Lamark.

NUCULA PARVA, McC.

Pl. 26. Fig. 8.

Nucula parva, MCCHESNEY, 1860. Descrip. New Pal. Foss., p. 54; and illustrations of same, Proceed. Chicago Acad. Sci., Vol. I, p. 39, pl. 2, fig. 8, *a*, *b*, *c*.

Position and locality—Coal Measures, Danville, Illinois.

NUCULA BEYRICHI, v. Schauroth.

Pl. 26. Fig. 9.

? *Nucula Beyrichi*, v. SCHAUROTH, 1854. Zeitschr. d. Deutsch: Geol. Gess., VI, p. 551, Tab. 21, fig. 4. GEINITZ, 1861. Dyas., p. 67, Tab. XVIII, fig. 22-24; also 1866, in Carb. und Dyas. in Neb., p. 32, Tab. 1, Fig. 36-37.

Locality unknown; Coal Measures of Illinois.

GASTEROPODA.

Genus DENTALIUM, Linnæus.

DENTALIUM ? ANNULOSTRIATUM, M. and W.

Pl. 29, Fig. 7.

Dentalium ? annulostriatum, MEEK and WORTHEN. Proceed. Acad. Nat. Sci., Phila., 1870, p. 45.

SHELL very small, rather distinctly tapering and slightly arched; aperture and section circular; surface ornamented by regular, distinct, annular costæ, which pass around a little obliquely, and are separated by rounded furrows of the same breadth as the costæ themselves.

Length of a specimen incomplete at both ends, 0.28 inch; diameter at the larger end, 0.06 inch; do. at smaller end, 0.04 inch.

Of this delicate little shell we have seen but a single specimen, which is imperfect at both ends. At a first glance it might be mistaken for another more common species, of near the same size, occurring at the same locality, and which we are inclined to think is the *D. Meekianum*, of Geinitz. On examining it under a magnifier, however, it can be at once distinguished by its comparatively strong, regular costæ, instead of mere microscopic lines of growth.

It is with some doubt that we have referred this little shell to the genus *Dentalium*, because its small size and comparatively strong, regular costæ, give it much the appearance of the non-spiral part of the shell of a *Cæcum*. It is more arched, however, and more tapering than we generally see in the body part of the shells of that genus, which are likewise, we believe, unknown in any of the Palæozoic rocks.

Position and locality—Danville, Illinois. Roof of No. 7 coal, of the Illinois section of Coal Measures.

DENTALIUM MEEKIANUM, Geinitz?

Pl. 29, Fig. 8.

Dentalium Meekianum, Geinitz, 1866. Carb. und Dyas, in Neb., p. 13, Tab. I, Fig. 20.

Position and locality—Same as the last.

Genus ORTHONEMA, M. and W., 1861.*

(Proceed. Acad Nat. Sci., Phila., p. 146.)

ORTHONEMA CONICA, M. and W.

Pl. 29, Fig. 5.

Orthonema conica, MEEK and WORTHEN, 1866. Proceed. Acad. Nat. Sci., Phila., p. 270.

SHELL elongate conical, thin. Volutions (in adult examples) about nine, flattened nearly on a line with the slope of the spire, or but slightly convex; lower ones sometimes a little projecting at their lower margins immediately above the suture; last one distinctly angular around the middle, and but moderately produced below the angle, where it is a little convex. Umbilical region not indented. Suture generally well defined between the lower whorls, and merely linear above. Aperture rhombic-subquadrate. Surface showing, under a magnifier, small, very slightly oblique lines of growth, which are sometimes crossed on the middle of the flattened outer slope of the body whorl by very faint traces of two revolving ridges, and below the angle, on the under side, by traces of another revolving ridge.

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* For a description of this genus, accompanied by an illustration of the typical species, see Vol. II, of the Illinois Geological Reports, p. 380. 1866.

Length, 0.70 inch; breadth, 0.30 inch; apical angle a little convex on its slopes, divergence about 30 deg.

This species will be readily distinguished from our *O. Salteri*, the typical species of the genus, from the same locality and position, by its larger size, smaller number of whorls, greater apical angle, and particularly by never having the two linear revolving ridges just below the suture, so characteristic of that species. As mentioned in the description, it sometimes, though rarely, shows traces of two very obscure revolving ridges on the flattened part of the body whorl, but these are midway between its principal angle and the suture, while those on *O. Salteri* are always very distinct, and placed just below the suture. The principal angle on the body whorl of *O. Salteri* is also much more strongly defined, being a true carina.

From the several species of *Polyphemopsis* of our Coal Measures, such as our *P. inornata*, *P. peracuta*, etc., which it somewhat resembles, this species will be distinguished by its angular body whorl, and particularly by not having this whorl produced below, and its columella curved and truncated, so as to produce the peculiar effuse character at the base of the aperture seen in that genus.

Locality and position—Hodge's creek, Macoupin county, Illinois. Lower part of Coal Measures.

Genus NATICOPSIS, McCoy.

NATICOPSIS VENTRICOSUS, N. and P., sp.

Pl. 28, Fig. 13.

Natica ventrica, NORWOOD and PRATTEN, 1855. Jour. Academy Natural Sci., Philad., p. 76, Pl. IX, Fig. 10, a, b.

Naticopsis (Nerita) Pricei, SHUMARD, 1858. Transact. St. Louis Acad. Sci. Vol. I, p. 202.

SHELL ovate, oblique, longer than wide; spire very much depressed, obtusely rounded at apex; volutions two and a half or three, convex, the last one very large, regularly and rather strongly ventricose in young specimens, but as the shell advances in age its upper portion becomes gradually flattened and sometimes strongly channeled toward the aperture, and at the same time it becomes more or less shouldered just beneath the suture; below the flattened portion it is still evenly rounded to the base; suture indistinct at the apex, but gradually becoming more deeply impressed as it approaches the aperture; aperture large, rotundato-quadrate, its length usually a little greater than the width, very oblique to the axis of the shell, contracted below near the columella; lips sharp, strengthened above at its junction with the columella by the callosity of the latter; columellar lip thick, concave, callous, smooth; surface marked with numerous very fine lines of growth, and on the upper part of the volutions with rather strong plici-striæ, which curve obliquely forward to the suture. In some specimens the original coloring matter is still preserved, and the fossil presents a delicate vermilion hue.

Spiral angle from 120 to 130 degs; length from apex to base of an average specimen, 0.85 inch; greatest width, 0.82 inch; hight of aperture, 0.50 inch; width of same, 0.45 inch.

The foregoing is Dr. SHUMARD'S original description of *N. Pricei*, the type of which one of us has had an opportunity to examine carefully, and we now have before us an accurate tracing of it from a good drawing by Mr. ULFERS. It agrees so closely in almost every respect with the form we have figured that we can scarcely entertain a doubt of their identity. The specimen from which our drawing was made has the callous of the inner lip a little thicker above, and the columella rather more sinuous below, than the typical specimen of *N. Pricei*, but these are variable characters in different individuals of the same species in this genus.

The most perplexing question in regard to this shell is respecting its relations to *N. ventrica*, of Norwood and Pratten. On comparison with their figure and description, the shell we have figured will be seen to differ widely in nearly all its characters. Yet we are assured by Prof. E. COX that this particular specimen is the original type of *N. ventrica*, and that it was loaned by him to NORWOOD and PRATTEN for description and illustration. It seems scarcely possible, however, that the figure and description of *N. ventrica* could have been made from this individual specimen, and hence we think Prof. Cox may possibly be mistaken on this point, notwithstanding the fact that he loaned this specimen to Messrs. N. and P.

It is worthy of note, however, that Dr. SHUMARD describes the *N. Pricei* as being ventricose in young examples, and differing materially in form from the adult. Hence we suspect that NORWOOD and PRATTEN's type was a well grown young individual of the same species as that we have figured, and hence not distinct, specifically, from the subsequently named *N. Pricei*. At any rate we are assured by Prof. Cox that the form we have figured is the only one known to him from any locality near New Harmony, while we have before us two other good specimens from the locality one mile south of New Harmony, cited by NORWOOD and PRATTEN, and these agree exactly with that we have figured.

Position and locality—One mile south of New Harmony, Indiana; from the upper part of the Coal Measures.

Genus MACROCHEILUS, Phillips.

MACROCHEILUS ALTONENSIS, Worthen Ms.

Pl. 28, Fig. 8.

SHELL about the medium size, elongate-subovate, spire conical, forming about two-fifths the entire length of the shell, pointed at the extremity; volutions five or six, increasing moderately in size, last one not ventricose, widest just above the middle; columella provided with a thick rounded callosity, contracted at the upper extremity, and also about the middle, giving a sinuous outline to its upper margin. Surface smooth, but showing under the lens obscure lines of growth.

Position and locality—Lower Coal Measures, roof of the Alton coal seam; Alton, Illinois.

MACROCHEILUS NEWBERRYI, Stevens sp.

Pl. 28, Fig. 14.

Loxonema Newberryi, STEVENS. Am. Jour. Sci., Vol. 25, n. s., p. 259.

Position and locality—Roof of Danville coal; Danville, Vermilion county, Illinois.

Genus ACTÆONINA, D'Orbigny.

ACTÆONINA MINUTA, Stevens sp.

Pl. 29, Fig. 2.

Loxonema minuta, STEVENS. Am. Jour. of Sci., 1858, Vol. 25, n. s., p. 260

Position and locality—Roof of Danville coal; Danville, Illinois.

Genus PLATYCERAS, Conrad.

PLATYCERAS SPINIGERUM, Worthen Ms.

Pl. 28, Fig. 4.

SHELL rather small, elongate oval in outline, strongly recurved, apex pointed, and slightly twisted to the left (when looking at the shell with the apex behind), aperture ovate, with sinuous depressions extending from the aperture nearly to the apex, crossed by transverse marks of growth, giving a rugose appearance to the surface. Right hand side of the shell, as seen with the apex behind, depressed, or concave; the opposite side convex, and bearing the bases of several small, scattering spines, extending up about two-thirds the distance to the apex.

This species may be readily distinguished from any other known in the Coal Measures, from its sinus-like, longitudinal depressions and the spines upon its surface.

Position and locality—Roof shales of Coal No. 6; near Brighton, Illinois.

NATICOPSIS SUBOVATUS, Worthen Ms.

Pl. 28, Fig. 9.

SHELL of medium size, ovate in outline, whorls about three, spire flattened, and occupying about one-third of the entire length of the shell. Columellar lip thickened by a broad, flat callosity, indistinctly striated longitudinally. Outer whorl regularly ventricose, and indistinctly granulose on the surface.

This species differs from the preceding, as well as from *N. Altonensis*, in having its suture less strongly defined, its spire more flattened, and in not having any flattening or depression in the outer volution below the suture, and in the absence of the transverse striæ upon the surface.

Associated with this shell we found two or three specimens of an opercula, that we have suspected may belong to this species, and therefore have figured them in connection with it. Pl. 28, fig. 10.

Position and locality—Upper Coal Measures; La Salle, Illinois.

NATICOPSIS WHEELERI, Swallow's sp.

Pl. 28, Fig. 3.

Littorina Wheeleri, SWALLOW, 1860. Trans. St. Louis Acad. Sci., Vol. I, p. 658.

Position and locality—Upper and Lower Coal Measures; Springfield, Alton and various other localities in Illinois.

NATICOPSIS ALTONENSIS.

Pl. 28, Fig. 11.

Natica Altonensis, MCCHESNEY? 1865. Desc. New Paleo. Foss.
Naticopsis Altonensis, same. Trans. Chicago Acad. Sci., Vol. I, p. 50; Pl. 2, Fig 14.

Position and locality—Limestone below the Hodge's creek coal; Macoupin county, Illinois.

Genus STREPTACIS.

STREPTACIS WHITFIELDI, Meek.

Pl. 29 Fig. 1.

Streptacis Whitfieldi, MEEK. Proceed. Acad. Nat. Sci., Phila., 1871, p. 173.

Position and locality—Roof of Danville coal; Danville, Illinois.

Genus LOXONEMA.

LOXONEMA SEMICOSTATA, Meek.

Pl. 29, Fig. 2.

Loxonema semicostata, MEEK, 1871. Proceed. Acad. Nat. Sci., Phila., p. 174.
Chemnitzia attenuata, STEVENS, 1858. Am. Jour. Sci., Vol. 25, n. s., p. 259. (Not *Loxonema attenuata*, Hall, 1859.)

Position and locality—Roof of Danville coal; Danville, Illinois.

Genus ACLIS, Loven.

ACLIS ROBUSTA, Stevens.

Pl. 29, Fig. 6.

Aclis robusta, STEVENS, 1858. Am. Jour. Sci Vol. 25, n. s, p. 259.

Position and locality—Roof of Danville coal; Danville, Illinois.

Genus POLYPHEMOPSIS, Portlock.

POLYPHEMOPSIS CHRYSALLIS, M. and W.

Pl. 28, Fig. 7.

Polyphemopsis chrysallis, MEEK and WORTHEN, 1866. Proceed. Acad. Nat. Sci., Phila., p. 267.

SHELL small, subfusiform; spire conical, moderately elevated, pointed at the apex; volutions nine, a little convex, and increasing gradually in size, last one forming about two-thirds the entire length, and rather produced below; suture distinct, aperture narrow-suboval, acutely angular above, and narrowly effuse below; inner lip apparently wanting; columella a little arched and twisted; surface showing only very faint traces of lines of growth.

Length, about 0.55 inch; breadth, 0.23 inch; apical angle with convex slopes, divergence about 40 deg.

This species has nearly the form of *Loxonema Newberryi*, of Stevens, (an elongated *Machrocheilus*,) but it is much smaller, and wants the characteristic fold on the columella seen in that shell. In size it agrees more nearly with our *Polyphemopsis inornata*, from the upper part of the Coal Measures at Springfield, Illinois. It has the body volution more produced below, however, and without any tendency to form an obtuse angle around the middle, while the slopes of its spire are more convex in outline, owing to the proportionally larger size of the middle whorls. This latter character gives it the chrysalis-like form that suggested the specific name.

Locality and position—Hodge's creek, Macoupin county, Illinois; from the lower part of the Coal Measures.

Genus ANOMPHALUS, M. and W.

Anomphaus rotulus, M. and W.

Pl. 29, Fig. 10.

Anomphalus rotulus, Meek and Worthen, 1866. Proceed. Acad. Nat. Sci., Phila., p. 268.

Shell small, depressed, narrowly rounded on the periphery; spire scarcely visible above the body whorl in a side view; volutions three and a half to four, increasing rather rapidly in breadth, last one sloping with a moderate convexity between the suture and the periphery, and slightly excavated in the umbilical region; suture not impressed; aperture transversely suboval, being rounded on the outer side, and straightened on the lower half of the inner side, but modified by the convexity of the body whorl above; surface showing scarcely any traces of lines of growth, even under a good magnifier.

Breadth of a large specimen, 0.19 inch; hight, 0.07 inch.

Position and locality—Hodge's creek, Macoupin county, Illinois; lower division of Coal Measures.

Genus MICRODOMA, M. and W.

MICRODOMA CONICA, M. and W.

Pl. 28, Fig. 2.

Microdoma conica, MEEK and WORTHEN, 1866. Proceed. Acad. Nat. Sci., Phila., p. 269.

SHELL rather elongate-conical, or elevated subtrochiform; volutions seven, flattened on a line with the slope of the spire, increasing rather gradually in size, last one extended a little below the mesial angle, where it is only marked by minute striæ of growth; suture rather deep; aperture a little oblique, and oval-subrhombic in outline. Surface ornamented by three distinct revolving nodular ridges, the largest and lowest of which occupies the mesial angle of the body whorl, and passes around immediately above the suture of the whorls of the spire, while the upper one occupies the upper margin of all the whorls just below the suture, and the third one passes around midway between the others. Lines of growth small, and crossing the flattened sloping sides of each whorl so obliquely as to indicate a distinct forward extension of the outer lip above, at its connection with the body whorl. Nodes of the revolving ridges small, closely and regularly arranged on the different ridges, so as to form oblique rows parallel to the lines of growth.

Length, 0.21 inch; breadth, 0.12 inch; apical angle with straight slopes; divergence, 30 deg.

This species seems to be nearly related to *Pleurotomaria serrilimba*, of Phillips, judging from his figure, but the description of that shell is so very brief and unsatisfactory that we have no means of making a close comparison.

Locality and position—Lower part of Coal Measures; Macoupin Co., Illinois.

MURCHISONIA INORNATA, M. and W.

Pl. 28, Fig. 6.

Murchisonia inornata, MEEK and WORTHEN, 1866. Proceed. Acad. Nat. Sci., Phila., p. 274.

SHELL very small, conic sub-ovate; axis imperforate; spire rather short (for a *Murchisonia*); volutions six, convex, increasing rather gradually in size, last one forming more than half the entire shell, most prominent around the middle, but not even obtusely angular, a little produced below; suture impressed; aperture slightly oblique, sub-ovate in outline, being angular above and rounded and apparently faintly effuse below; spiral band not distinguishable from the general surface of the whorls, excepting as indicated by the curve of the minute lines of growth seen by the aid of a magnifier, apparently of moderate breadth, and placed about half way between the middle and the upper side of the body whorl, passing around near the middle of those of the spire. Surface appearing nearly smooth to the eye, but when examined with a magnifier, seen to be ornamented with small, obscure, revolving striæ, most distinct below the middle of the body whorl; crossing these, traces of very minute lines of growth may be seen by the aid of a good lens, in a favorable light, curving strongly backwards as they approach the undefined spiral band.

Length, 0.22 inch; breadth, 0.13 inch; apical angle, about 38 degs.

This is one of those intermediate forms that might, as far as can be determined by the shell alone, be referred, with almost equal propriety, to either *Murchisonia* or *Pleurotomaria*, though agreeing rather more nearly with the former. It will be readily distinguished from all the little species of either of these genera known to us, that agree with it, in being without costate or carinated whorls, by its nearly smooth surface, by its nearly obsolete spiral band. Excepting in its much smaller size, and less produced body whorl, it has somewhat the look of *Murchisonia melanoides*, de Koninck (An. Foss., pl. III, fig. 14, *a*, *b*,) but the more produced lower part of the body whorl of that shell gives its aperture a different form, while it has a well defined spiral band occupying a lower position on the whorls, and no traces of a revolving line.

Locality and position—Hodge's creek, Macoupin county, Illinois; lower part of Coal Measures.

PLEUROTOMARIA COXANA, M. and W.

Pl. 28, Fig. 15.

Pleurotomaria Coxana, MEEK and WORTHEN, 1866. Proceed. Acad. Nat. Sci., Phila., p. 272.

SHELL attaining a large size, obliquely conoid-subtrochiform, longer than wide; spire turreted, forming rather more than half the entire length. Volutions six to seven, convex, very prominent or obtusely sub-angular below the middle, at which point those of the spire project out over the suture; all flattened or slightly concave above, with an outward slope of about thirty-five degrees with the vertical axis of the shell, from the suture to the most prominent part, where the spiral band is placed; below this the underside is rounded convex to the small, umbilical perforation. Suture strongly defined by the convexity of the whorl just above it. Aperture subquadrate, approaching sub-circular in adult shells. Surface ornamented by exceedingly fine, regular lines of growth, that run very obliquely backwards, with a slight forward curve in passing down the sloping upper side from the suture to the spiral band at the most prominent part of the whorls; between this and the umbilical perforation below they make a backward curve. Casts also show traces of apparently much stronger revolving lines near the umbilicus.

Hight about 2.50 inches; breadth about 2.10 inches.

The specific name was given in honor of Prof. E. T. Cox, of New Harmony, Indiana, to whom we are indebted for the use of the best specimen of the species we have seen.

Locality and position—Iron ore beds, belonging to the lower part of the Coal Measures; at Nolin's Furnace, Edmondson county, Kentucky.

PLEUROTOMARIA SPIRONEMA, M. and W.

Pl. 28, Fig. 5.

Pleurotomaria spironema, MEEK and WORTHEN, 1866. Proceed. Acad. Nat. Sci., Phila., p. 272.

SHELL under medium size, sub-globose, with length and breadth nearly equal. Volutions five or six, increasing rather rapidly in size; those of the spire, convex; the last one forming more than four-fifths of the entire length, and so much as nine-tenths the entire bulk of the shell, rounded regularly from the suture above to the umbilicus below, excepting near the aperture, where it is a little more prominent below than above the middle. Aperture sub-orbicular in general outline, but rather strongly modified above the middle on the inner side, by the return of the body whorl. Inner lip slightly thickened and deeply arcuate below, but wanting or exceedingly thin above the middle of the aperture; columella tortuous, with a slightly impressed furrow at the outer margin of the inner lip, but without an umbilical perforation. Surface ornamented with regular, distinct, revolving striæ, crossed just below the suture by short, little node-like folds, confined to the narrow space between the suture and the spiral band; similar but smaller, more crowded and longer curved wrinkles also radiate from the umbilical region on the under side of the body whorl. Lines of growth obscure on all the specimens seen. Spiral band flattened so as to be even with the general surface, nearly smooth, and placed half way between the middle of the body whorl and the suture above, or about once and a half its own breadth below the suture.

Length and breadth of a medium sized specimen, each 0.45 inch; length of aperture, 0.25 inch; breadth of do., 0.23 inch; apical angle, with convex slopes, divergence, 90 degs.; breadth of spiral band at the aperture, 0.07 inch.

This species is nearly related to *P. Beckwithana*, of McChesney (New Palæozoic Fossils, p. 61,) with which we supposed it to be identical, from Prof. McCHESNEY'S description, until we had an opportunity to compare it with good examples of that species from the original locality. On comparison with these, we find our shell to be readily distinguished by having its spiral band located midway between the middle and upper margin of the body whorl, instead of passing around the middle of the outer side. It likewise differs in showing no traces of revolving striæ on the spiral band, and in having small wrinkles across the revolving striæ on the under side of the body whorls, while the little wrinkles around the upper edge of the whorls are stronger and shorter than in *P. Beckwithana*. Again, there is a difference in the revolving striæ—those of our shell never having an intermediate, smaller one between two larger ones, as is generally the case with those of Prof. McCHESNEY'S species.

The close similarity between these two species, both in form and ornamentation, shows the necessity for great care and precision in drawing up descriptions of specimens, even where they may be widely different from all *known* forms, since we often find in such cases that other really distinct species are afterwards discovered that cannot be distinguished by the original description from forms already described.

Locality and position—Lower member of the Coal Measures on Hodge's creek, Macoupin county, Illinois.

PLEUROTOMARIA? VALVATIFORMIS, M. and W.

Pl. 29, Fig. 9.

Pleurotomaria valvatiformis MEEK and WORTHEN, 1866. Proceed. Acad. Nat. Sci., Phila., p. 273.

SHELL minute, depressed, or about twice as wide as high; volutions three and a half to four, regularly rounded, and increasing rather gradually in size; suture well defined, in consequence of the convexity of the whorls; umbilicus proportionally small, or closed; aperture sub-orbicular, being a little straighter on the inner side. Spiral band nearly or quite even with the surface of the whorls, and placed on the middle of the outer side. Surface smooth, as seen without a magnifer, but presenting traces of microscopic revolving striæ, in a good light under a strong lens.

Hight, 0.04 inch; breadth, 0.08 inch.

This is by far the smallest *Pleurotomaria* (if it really belongs to that genus) we have ever seen, and if it were not for the fact that we find so many specimens of it not exceeding the dimensions given above, while no nearly allied large species is known in the same association, we would think it might be a young shell. It is perhaps more nearly like our *P. micronema* than any of its associates yet known, but in addition to its vastly smaller size (although having nearly the same number of whorls), it differs in being much more depressed, and having proportionally much more slender whorls; while its spiral band passes around the middle of its body whorl, instead of between the middle and the upper margin. In the position of its band, it is nearer like *P. Beckwithana*, of McChesney, but it differs so widely from that species in size and other characters, as to render a close comparison unnecessary.

Locality and position—Lower part of the Coal Measures, on Hodge's creek, Macoupin county, Illinois.

PLEUROTOMARIA CONOIDES, M. and W.

Pl. 28, Fig. 1.

Pleurotomaria conoides, MEEK and WORTHEN, 1866. Proceed. Acad. Nat. Sci., Phila., p. 271.

SHELL small, regularly conoid trochiform, longer than wide, the breadth being to the length about as five to six. Volutions five or six, increasing regularly and rather gradually in size, all obliquely flattened nearly parallel to the slope of the spire, though the lower margin of each projects at the suture slightly beyond the upper edge of the succeeding one below; last one angular around the periphery at the base, and flattened on the under side at less than a right angle to the oblique slope above, but rounding abruptly into the minute umbilical perforation within. Aperture rhombic quadrangular, with nearly equal length and breadth; inner lip straight and parallel to the axis of the shell below, but curving out abruptly at its base. Surface ornamented with small, regular, oblique, arching striæ on the upper sloping sides of the whorls, and minute sigmoid lines, crossed near the periphery by faint traces of a few revolving striæ on the under side of the body whorl. Spiral band narrow, located at or slightly above the periphery of the body volution, and passing around its own breadth above the suture on the whorls of the spire; margined above and below by a raised line.

Length, 0.27 inch; breadth, 0.25 inch; apical angle with straight slopes; divergence, about 50 degs.

This species belongs to the trochiform section of the genus including *Pleurotomaria obtusispira*, and *P. Riddellii*, Shumard, and *P. turbiniformis*, M. and W., and *P. Missouriensis*, Swallow (sp.) It differs from all these shells, however, in being much smaller, although composed of about the same number of whorls; while it also differs from them all, excepting *P. obtusispira*, in having no revolving striæ on the upper side of its whorls, and from that species in having a more elevated spire, and rather coarse, instead of "extremely fine striæ of growth," on the upper slope of its whorls. In form and general appearance it resembles quite nearly *Trochus coniformis*, de Koninck (An. Foss., pl. XXXVII, fig. 4, *a*, *b*.) but differs in wanting the spiral striæ, and of course in the possession of a distinct but narrow spiral band.

Locality and position—Hodge's creek, Macoupin county, Illinois; lower Coal Measures.

Genus STRAPAROLLUS, Montfort.

STRAPAROLLUS (EUOMPHALUS) PERNODOSUS, M. and W.

Pl. 29, Fig. 14.

Straparollus (Euomphalus) pernodosus, MEEK and WORTHEN, 1870. Proceed. Acad. Nat. Sci., Phila., p. 45.

SHELL attaining a rather large size, subdiscoidal, or with the spire nearly on a plane with the upper outer edge of the volution; umbilicus broad, moderately deep, and showing all the inner turns; volutions about five and a half, flattened convex, and a little oblique on the broad periphery, but distinctly carinated near the outer side above (the carina being rugose), while a little outside of the middle below they are prominent and ornamented by a row of moderately distinct nodes, of which about sixteen may be counted on the last turn; those on the last half of the outer volution becoming nearly or quite obsolete toward the aperture. Upper side of each whorl flattened and sloping distinctly inward from the carina to the suture; lower side of same sloping rapidly inward, and slightly concave just within the prominent nodose ridge, and then rounding rather abruptly into the umbilicus. Surface marked by distinct lines, and at some places ridges of growth; on the upper side of the whorls these lines pass obliquely outward and forward from the suture to the carina, thence obliquely backward in crossing the periphery, while in crossing the under side they curve a little backward.

Greatest breadth of a specimen not quite complete at the aperture, 2.50 inches; hight at the aperture, about 0.84 inch.

Locality and position—Alton, Illinois; lower Coal Measures.

STRAPAROLLUS (EUOMPHALUS) SUBQUADRATUS, M. & W.

Pl. 29, Fig. 12 and 13.

Straparollus (Euomphalus) subquadratus, MEEK and WORTHEN, 1870. Proceedings Acad. Nat. Sci., Phila., p. 46

SHELL attaining nearly a medium size, discoid or subplan-orbicular, concave, and showing all the whorls both above and below, though the concavity is deeper below than above. Periphery nearly flat, rather broad, and more or less oblique, with a distinct carina at the upper and lower edges, the former of which is more acute than the other, and irregularly crenate, or subnodose, and projecting nearly upward, while the lower one is a little rounded, and projects outward. Volutions five or six, not embracing, nor coiled exactly in the same plane; on the upper surface each sloping, with a slight concavity, distinctly inward from the marginal carina to the suture, while the flattened outer side usually has an obscure longitudinal sulcus near the upper and lower angles, the upper one being a little deeper than the other. On the under side the whorls slope gently inward from the marginal angles so as to form a broad depressed-subconical umbilicus. Surface marked with rather strongly defined lines of growth, which, at places, become sub-imbricating, or form little irregular ridges. In crossing the upper side of the whorls, these lines start, at first, nearly at right angles from the sutures, but curve a little backward as they approach the marginal angle; and immediately after crossing this angle, and passing downward upon the nearly vertically flattened periphery, they are deflected a little forward, but soon after pass straight down to and over the lower marginal angle to the under side, where they extend obliquely backward and inward, with a rather distinct curve, to the immediate vicinity of the suture, and then curve a little forward. Aperture and sections of interior of whorls subcircular, or transversely oval.

Greatest breadth of a specimen with apparently about one-third of the outer volution broken away, 1.25 inches; hight, 0.50 inch. When entire this specimen was probably not less than 1.43 inches in breadth.

From the foregoing description it will be seen that this shell is nearly allied to the common Western Coal Measure species figured and described by Prof. HALL, in his Iowa Geological Report, under the name *Euomphalus rugosus*, (not *E. rugosus*, of Sowerby.*) Indeed it is so nearly like that species that we at one time suspected that it might be only a gigantic and more ventricose variety of the same. Yet on comparing our shell with an extensive series of good specimens of *E. rugosus*, Hall. it is found to be greatly larger than any known authentic examples of that shell, its breadth being a little more than twice and a half that of the usual mature examples of *E. rugosus*. Its umbilicus, and the concavity of its upper side, are also proportionally deeper, particularly the former, while the flattened outer side of its whorls is broader, and generally less oblique. Its lines of growth also differ in being rather distinctly deflected backward at the marginal angle of the upper side, so as to indicate an obscure sinus of the margin of the lip at the termination of this angle, though there are no traces of a band, as in *Pleurotomaria*. This character would probably place the species in the group for which the name *Schizostoma* was proposed by BRONN, but palæontologists have generally regarded the type for which that name was proposed as not being sufficiently distinct from *Euomphalus* to be retained as a separate genus.

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* If SOWERBY's species is really congeneric, the American form called *E. rugosus*, by Prof. HALL, might be distinguished by the specific name *subrugosus*.

Associated with the above a single specimen was found of the same size, and agreeing very closely with that from which the foregoing description was drawn up, but differing in being proportionally wider, and not so oblique on the periphery, which is also more convex in the middle. The angle of its under side also differs in being a little further in from the outer margin, and directed downward, instead of outward, while its umbilicus is proportionally deeper. This may be a distinct species, but without more specimens for comparison we do not feel willing to regard it as being entitled to a separate name.

These shells, including *E. rugosus*, Hall, and *E. catilloides*, Conrad (sp.), are related to *E. quadratus*, of McCoy, from the Mountain Limestone of Ireland, though sufficiently distinct specifically. At one time we were inclined to think that *E. rugosus*, Hall, and *E. catilloides*, Conrad, together with a few others, should be separated from *Euomphalus*, under a distinct generic name; but after seeing the large species we have here described, which so closely connect these little shells with such forms as *E. pentangulatus*, and *E. catillus*, upon which the genus was originally founded, we can no longer doubt that all of these shells really belong to one genus. This series of intermediate forms connecting the small, planorbicular species mentioned above, with the typical forms of *Euomphalus*, shows clearly that none of the former belong to the articulate genus *Spirorbis*, as has been thought by some, but that they are really true mollusks.

Position and locality—Montgomery county, Illinois. Upper Coal Measures.

STRAPAROLLUS (EUOMPHALUS) SUBRUGOSUS, M. and W.

Pl. 29, Fig. 11.

Euomphalus rugosus, HALL, 1858. Iowa Geol. Report, Vol. I, Part 2, p. 722; Pl. 29, Fig. 14, (not *E. rugosus*, Sowerby, 1849.)

Locality and position—Common in the roof shales above No. 8 coal, near Springfield, Illinois, and also found more rarely in the lower part of the Coal Measures.

Genus CHITON, Linnæus.

CHITON CARBONARIUS, Stevens.

Pl. 29, Fig 15.

Amer. Jour. Sci., 1859, Vol. 25, new series, p. 264.

Position and locality—Roof of the Danville coal, Danville, Illinois.

CEPHALOPODA.

NAUTILUS (TEMNOCHILUS) LATUS, M. and W.

Pl. 30, Fig. 2.

Nautilus (Temnochilus) latus, MEEK and WORTHEN, 1870. Proceed. Acad. Nat. Sci., Phila., p. 49.

THE only specimen of this fine species we have ever seen consists of about half of one volution, which, being without septa, must belong to the part composing the last or body chamber, originally occupied by the body of the animal. It is broken at both ends, and measures around the curve of the outer side, 8.50 inches, with, at the larger end, a dorso-ventral diameter of 2.10 inches, and a transverse diameter (including the nodes) of 3.60 inches. The dorso-ventral diameter at the smaller end is about 1.60 inches, and the transverse about 2.40 inches. A section of the body volution is transversely subelliptical, with a tendency to an oblong outline; the outer (often called the dorsal) side of the whorl being very broad and flattened convex, and each lateral margin, exclusive of the nodes, being rather narrowly rounded, or a little flattened, while the inner side is a little concave. The broad flattened outer side has two very obscure longitudinal ridges, with a distinctly flattened space between. Along each (so-called) dorso-lateral margin there is a row of prominent flattened nodes, arranged at intervals of about their own greater (antero-posterior) diameter. About sixteen of these nodes occupied each side of the outer or last volution. The inner side of the whorl rounds regularly into the umbilicus, which appears to be wider than the dorso-ventral diameter of the volution at the aperture. The surface is without longitudinal lines, but the striæ of growth are moderately distinct, especially on the broad flattened outer side, where they make a deep backward curve in crossing, so as to indicate the presence of a very deep sinus in the lip on that side of the aperture of the shell.

In the specimen described the substance of the shell is thin, and scarcely mineralized, though it retains no pearly lustre.

Position and locality—Carbon Cliff, Rock Island county, Ill. Roof of Coal No. 1. For the fine specimen from which the foregoing description was made out we are indebted to WILLIAM S. THOMAS, Esq., who found it at the locality above cited.

NAUTILUS (TEMNOCHEILUS) WINSLOWI, M. and W.

Pl. 32, Fig. 2.

Nautilus (Temnocheilus) Winslowi, MEEK and WORTHEN, 1870 Proceedings Acad. Nat. Sci., Phila., p. 50.

SHELL attaining a moderately large size, subdiscoidal; periphery broad and nearly flat, the middle third being rather distinctly flattened, while on each side of this there is a very slight slope outward to the lateral margins. Umbilicus broad, moderately deep, and showing nearly the full breadth of each inner volution on each side. Volutions apparently about four and a half, with transverse diameter nearly one-third greater than the dorso-ventral; each ornamented around the lateral margins of the broad periphery by about sixteen very prominent rounded nodes, which project obliquely outward, at an angle about intermediate between the general plane of the shell and that of the broad periphery, those on opposite sides being alternately arranged; from these rows of nodes the sides slope abruptly inwards, with a moderate convexity, to their inner margins within the umbilicus. Surface marked by rather well defined lines of growth, which curve gently backward in crossing the sides of the whorls from the inner margin, and make a strong backward curve in crossing the periphery, so as to indicate the presence of a deep rounded sinus in the outer margin of the lip. (Siphuncle and septa unknown.) Greatest breadth of a specimen with a part of the outer volution broken away, 4.60 inches; transverse diameter of outer turn, measuring across the periphery without including the nodes, 2.46 inches; do., including the nodes, 2.95 inches; dorso-ventral diameter of the outer volution, 1.66 inches.

This species is evidently closely allied to the last in form and general appearance, but differs in having its volutions proportionally narrower, measuring at right angles to the plane of the shell. Its most marked difference, however, consists in the form of its nodes, which are round, instead of being distinctly compressed. It seems to be related to *N. tuberculatus*, of Sowerby, but differs from the published figures of that species in having its periphery proportionally broader, and distinctly more flattened, while its nodes are placed nearer the outer margin of the whorls, as well as more prominent. From *N. occidentalis*, of Swallow (= *N. quadrangularis*, McChesney,) it will be readily distinguished by the greater transverse diameter of its whorls, which are also without the flattened sides of that species, and differs in wanting the two mesial rows of nodes on the periphery.

The specific name of this fine *Nautilus* is given in honor of Dr. J. C. WINSLOW, of Danville, Illinois, to whom we are indebted for the use of the specimen from which the description was drawn up.

Locality and position—Danville, Illinois. Roof shales of Coal No. 7 of the Illinois section of the Coal Measures.

NAUTILUS LASALLENSIS, M. and W.

Pl. 31, Fig. 1.

Nautilus Lasallensis, MEEK and WORTHEN, 1866. Proceed. Acad. Nat. Sci., Phila., for Dec., 1865, p. 261.

SHELL attaining a medium size, sub-discoidal; umbilicus more than half as wide as the dorso-ventral diameter of the last whorl at the aperture, moderately deep, and showing about half of each inner turn. Volutions increasing rather gradually in size, very slightly compressed on the dorsal and lateral surfaces, but without the compression imparting any angularity to the dorso-lateral and ventral margins, which are rounded; each turn concave within for the reception of the inner volutions. Septa moderately concave, separated by spaces measuring on the outer side less than one-third the dorso-ventral diameter of the whorls at the point of measurement, all crossing the lateral and outer sides of the volutions with a broad backward curve. Siphon scarcely more than its own breadth from the inner margin. Aperture, judging from the section of the whorls, about as wide transversely as its dorso-ventral diameter, sub-quadrilateral, approaching sub-reniform, in consequence of the sinuosity of the inner side. (Surface unknown.)

Greatest diameter, about 4.70 inches; convexity, about 2.75 inches; breadth of umbilicus, 1.45 inches.

This species differs from all of the others resembling it in other respects, known to us, from our rocks, in having its volutions without any traces of nodes.

Locality and position—Upper Coal Measures; La Salle, Illinois.

GONIATITES COMPACTUS, M. and W.

Pl. 31, Fig. 2.

Goniatites compactus, MEEK and WORTHEN, 1865. Proceed. Acad. Nat. Sci., Phila., p. 154.

SHELL subdiscoidal; umbilicus wide, or about twice the dorso-ventral diameter of the last turn near the aperture, moderately deep, and showing about half of each inner turn. Volutions four, nearly twice as wide as the diameter in the direction of the plane of the shell, broadly rounded externally, and each provided with a broad moderately deep concavity on the inner side for the reception of the next whorl within; sides rather narrowly rounded near the umbilicus, and rounding off more gradually to the periphery, the most prominent part being within the middle. Aperture (as inferred from a section of the whorl) transversely subreniform. Septa with a single pointed lobe on each side; dorsal lobe infundibuliform, the narrow portion being lanceolate; dorsal saddle broadly and very obtusely rounded; superior lateral lobe from one-fourth to one-third larger than the dorsal, and having much the same shape, excepting that it is proportionally wider; inferior lateral lobe consisting merely of a broad rounded sinuosity. (Surface unknown.)

Should Montfort's name *Aganides* be retained, the name of this species would become *Aganides compactus*.

Greatest diameter, 2.50 inches; convexity (or breadth of aperture,) 1.33 inches; breadth of umbilicus, about 1.12 inches.

This species is sufficiently distinct from all others known to us to render comparison unnecessary.

Position and locality—Coal Measures; Menard county, Illinois.

Genus ORTHOCERAS.

ORTHOCERAS RUSHENSIS, McC?

Pl. 30, Fig. 4.

Orthoceras Rushensis, McCHESNEY, 1860. New Pal. Foss., p. 68.

Locality and position—Upper Coal Measures. Springfield, Illinois.

ARTICULATA.

Genus PHILLIPSIA, Portlock.

PHILLIPSIA (GRIFFITHIDES) SCITULA, M. and W.

Pl. 32, Fig. 3.

Phillipsia (Griffithides) scitula, MEEK and WORTHEN, 1865. Proceed. Acad. Nat. Sci., p. 270.

SMALL, entire outline nearly elliptic. Cephalic shield semi-elliptic, very convex, about one-third its breadth wider than long, rounded anteriorly, and nearly straight behind, with posterior lateral angles produced backwards into rather stout, carinated, pointed spines, which extend as far back as the fifth thoracic segment. Glabella broadly rounded and sloping in front, where it is without a projecting marginal rim; distinctly contracted posteriorly, in which region it is most elevated; separated from the cheeks on each side by its much greater convexity, and a shallow furrow, which becomes obsolete around the front; posterior lateral lobes comparatively large, subtrigonal, very oblique, depressed, and isolated by the strongly defined lateral furrows in front of them being so very oblique and produced as to intersect the neck furrow; midway between these two lobes there is a more prominent mesial node, isolated by an accessory furrow passing across in front of it, so as to cut it off, as it were, from the narrow posterior central part of the glabella; second and third lateral lobes very small, transverse, and obscurely defined by short, nearly obsolete linear furrows; anterior lobe larger than all the remaining portions of the glabella between it and the neck furrow. Neck segment a little higher in the middle (where it is provided with a minute tubercle) than the glabella, strongly arched upwards (not forward), and more than twice as wide, antero-posteriorly as one of the thoracic segments; neck furrow deep, broad, and arched with the neck segment. Eyes comparatively large, or half as long and (behind) nearly as prominent as any part of the glabella, located with their posterior margins opposite the neck furrow, and less than half their own length in advance of the posterior margins of the cheeks, visual surface ventricose, or subhemispherical, smooth, or even polished, as seen under a good pocket lens, but when examined by a high magnifying power, showing numerous, regularly disposed, minute lenses beneath the smooth, transparent outer crust; palpebral lobes semicircular, convex, and resting upon the eyes like lids. Cheeks, as compared with the size of the eyes and glabella, small, sloping abruptly from the eyes into the deep, broad, marginal furrow, which becomes suddenly obsolete on reaching the anterior lateral margins of the glabella, and extends backward to or even a little upon the posterior lateral, sub-spiniform appendages; posterior margins with an elevated rim, strongly defined by the deep continuation of the neck furrow; lateral margins showing, as seen from above, a narrow rim, which, in a side view, is seen to be deep, vertically flattened, and marked by fine, parallel, longitudinal striæ: anteriorly it continues around the front of the glabella, but does not project so as to be visible from above, while its upper margin is continued in the form of a carina along the middle of the posterior lateral spines to their points. Facial sutures cutting the anterior border in front of the eyes, and the posterior margins of the cheeks behind the outer margins of the eyes. Thorax nearly as long as the head, but somewhat narrower, very distinctly trilobate: mesial lobe prominent, rounded, and a little wider than the lateral lobes; its nine segments narrow and sub-angular. Lateral lobes depressed and flattened near the mesial lobe, and so abruptly sloping from the outer side of this flattened space, as to impart a slight angularity along that region; segments corresponding in size with the segments of the mesial lobe, and distinctly kneed near the middle, outside of which they are bent down and obliquely flattened for folding together, and rounded at the extremities. Pygidium very convex, smaller than the cephalic shield, forming more than a semicircle, with anterior lateral angles obliquely truncated; posterior outline regularly rounded, with a moderately wide, smooth, depressed, nearly flat or sloping marginal zone; trilobation as in the thorax, strongly defined; mesial lobe prominent, as wide anteriorly as one of the lateral lobes, including its border, distinctly flattened on each side, slightly tapering to an obtuse termination, less than half its own greatest anterior breadth from the posterior edge, segments eleven or twelve, well defined above, but nearly obsolete on the flattened sides. Lateral lobes convex, but distinctly less so than the mesial lobe, horizontally flattened near the latter, with an angle along the outer margin of the flattened space, from which the sides slope abruptly to the flattened, smooth border; segments six, simple, geniculated or bent down in the middle very distinctly, but terminating abruptly at the rather wide border; each with a minute pustule on the knee. Surface of glabella and all the segments more or less granular, the granules being larger on the posterior part of the glabella and neck segment than elsewhere.

Entire length, 0.60 inch; length of pygidium, 0.19 inch; breadth of do., 0.27 inch; length of thorax, 0.18 inch; breadth of do., 0.28 inch; length of cephalic shield, 0.23 inch; breadth of do., 0.32 inch.

Locality and position—Upper part of Coal Measures, at Springfield, Illinois.

PHILLIPSIA (GRIFFITHIDES?) SANGAMONENSIS, M. and W

Pl. 32, Fig. 4.

Phillipsia (Griffithides?) Sangamonensis, MEEK and WORTHEN, 1865. Proceed. Acad. Nat. Sci., Phila., p. 271.

ENTIRE outline elongate sub-ovate. Cephalic shield very convex, forming more than a semicircle, and about one-third wider than long; regularly rounded in front and straight behind, with posterior lateral angles produced into rather broad, carinated, pointed or sub-spinous appendages, equaling in length the distance from the posterior side of the cheeks to the anterior end of the eyes. Glabella ventricose, very prominent, separated from the cheeks on each side by a moderately distinct furrow, which also passes around the front; most convex behind the middle, thence rounded and declining to the rounded front, about one-fourth longer than wide, and slightly wider between the eyes than anteriorly; sides nearly parallel, but a little sinuous at the middle; posterior lateral lobes comparatively large, subtrigonal or tuberculiform, and entirely isolated by the distinct lateral furrow passing obliquely across with a backward curve, from opposite the middle of each eye, so as to intersect the neck furrow, second lateral lobes much smaller and more obscure than those behind, and also oblique, being merely defined by a faintly impressed, curved, oblique line; in advance of these there are also obscure indications of two other short, nearly obsolete lateral furrows, scarcely visible without the aid of a lens. Occipital segment well defined, but lower and considerably shorter in its transverse diameter than the glabella; strongly arched upwards (not forward) and projecting backwards a little behind the posterior line of the cheeks; neck furrow distinct, and arched upward with the occipital, or neck segment; its continuation along the posterior sides of the cheeks very deep, and nearly straight for about two-thirds of the way across towards the lateral margins, where it intersects another furrow or depression coming around the sides of the cheeks. Eyes lunate, rather large, or nearly half as long as the glabella, exclusive of the neck segments, prominent, but not as high as the glabella, located about half their own length in front of the posterior margin of the cheeks; visual surface smooth, or even apparently polished, and showing no traces of lenses under a good magnifier; palpebral lobes convex, but resting like a lid upon each eye. Cheeks sub-trigonal, declining abruptly from the eyes; lateral margins turned downward, and forming below a sharp edge, which continues back along the lower margin of the posterior spine-like appendages; above this there is a vertically flattened, or even concave zone or belt, extending from near the front part of the glabella around the outer side of each cheek, and becoming a shallow furrow as it passes back upon the spines, along which it seems to be more or less marked nearly to their pointed extremities; between this vertically flattened band and the eyes, there is another nearly horizontally flattened, or outwardly sloping zone, extending around each cheek from near the front posteriorly, so as to unite with the lateral connections of the neck furrow behind, and continue as a single furrow along the upper margin of the posterior spines, thus leaving a more or less defined mesial ridge between these two furrows the entire length of the posterior lateral spiniferous appendages, as well as around the cheeks, to near the front of the glabella; posterior margins of the cheeks, behind the continuations of the neck furrow, very prominent, or forming a thickened rim. Facial sutures extending obliquely forward and outward from the anterior side of the eyes, and again curving inwards, so as to cut the anterior margin nearly on a line with the anterior inner extremity of the eyes; from the posterior end of the eyes, directed obliquely outward and backwards, so as to intersect the posterior margin nearly midway between the neck segment and the sub-spiniferous lateral posterior appendages.

Thorax only known from a few of the posterior segments, which show the mesial lobe to be wider and distinctly more prominent than the lateral lobes, which are flattened near the mesial lobe, and abruptly deflected downwards near the middle; segments divided by a furrow near the anterior side from the knee inwards, and flattened in the direction of the axis at the rounded outer extremities.

Pygidium semi-elliptic, slightly wider than long, and rather convex, distinctly narrower and a little longer than the cephalic shield, narrowing backwards, and narrowly rounded at the posterior extremity. Mesial lobe prominent, a little flattened on each side, and narrower than the lateral lobes, from which it is distinctly separated by broad, strong furrows; tapering gradually backwards, and terminating rather abruptly near one-third its own length from the posterior margin, so as to leave a broad, nearly flat, or more or less sloping, smooth border, which extends along each side the whole length of the pygidium, but becomes narrower anteriorly; segments of mesial lobe seventeen or eighteen, well defined, rounded, and very nearly or quite straight. Lateral lobes more depressed, and about one-third or one-fourth wider than the mesial lobe, rounding down rather abruptly to the lateral margins; segments nine or ten, rounded, simple, and separated by distinct furrows; all terminating abruptly at the inner edge of the broad, smooth marginal zone.

Entire surface apparently very nearly smooth.

Length of cephalic shield, exclusive of posterior lateral spines, 0.45 inch, breadth of same, 0.66 inch, hight of do., 0.31 inch. Length of glabella, exclusive of the neck segment and anterior border, 0.36 inch; breadth of same across the posterior lateral lobes, 0.29 inch; do. of same across the constricted central region, 0.25 inch; do. of same anteriorly, 0.28 inch. Length of eyes, 0.18 inch. Length of pygidium, 0.50 inch; breadth of do., 0.55 inch.

Locality and position—Springfield, Illinois. Upper Coal Measures.

Genus DITHYROCARIS, Scouler.

Dithyrocaris carbonarius, M. and W.

Pl. 32, Fig. 1.

Dithyrocaris carbonarius, Meek and Worthen, 1869. Proceed. Acad. Nat. Sci., Phila.

We only know this fossil from a specimen showing the caudal appendages—that is, the telson* and stylets. These are lanceolate in general outline, and rather flattened. The telson seems to be a little shorter than the stylets, and more rapidly tapering toward the extremity. Below, it is flattened, and has a faint, undefined, obtuse, longitudinal ridge along the middle, with on each side an equally undefined, shallow sulcus between this and the lateral margins, which are sharp. On its upper side there is a well defined mesial carina, with a slightly concave slope on each side to the lateral edges; thus presenting much the appearance of a broad, miniature bayonet. The stylets have each on the flattened under side about six or seven small, longitudinal ridges, and on the upper side a distinct longitudinal mesial carina, between which and the lateral margins there is on each side a smooth, rounded concavity, or broad furrow; along each lateral margin there are two closely approximated carinæ, one above and one below, with a narrow sulcus between.

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* If the middle one of the three nearly equal caudal appendages in this genus is not articulated at its base, it would only be, properly, an attenuated terminal part of the telson, and not the whole of that appendage.

Length of telson, about 0.75 inch; breadth of do., 0.12 inch; length of stylets, about 0.80 inch; breadth of do. near the articulating end, 0.12 inch.

This species will be readily distinguished from *D. Scouleri*, of McCoy, by its proportionally broader, and more lanceolate stylets and telson, the latter of which also differs in being smooth above, instead of marked with divaricating striæ, as in the *Scouleri*. Its stylets are also flatter, and carinated instead of being rounded. From Portlock's *C. Colei*, it will be distinguished by having the carinæ of its stylets and telson smooth, instead of crenate.

So far as we are informed, this is the first species of this genus found in America. It is another example of a very decided Carboniferous genus added to the many others now known to be associated in the Coal Measures of Illinois, with numerous fossils that occur in Coal Measure rocks on the Missouri, in Nebraska, that have been by some geologists wrongly referred to the Permian (=Dyas).

Locality and position—Near the middle of the Coal Measures, at Danville, Illinois; associated with numerous upper Coal Measure fossils.

ERRATA.

Page 85, 15th line from the bottom, for "flame," read vein.
Page 109, 3d line from the top, for "morraines," read moraines.
Page 118, 14th line from the bottom, for "Saccaroidal," read Saccharoidal.
Page 119, 5th line from the bottom, for "desired be," read be desired.
Page 135, 8th line from the top, for "water's bed," read watershed.
Page 161, 13th line from the bottom, for "is such," read in such.
Page 230, 11th line from the top, for "*histrix*" *hystrix*.
Page 275, 2d line from the bottom, for "*Archiocidaris*," read *Archæocidaris*.
Page 289, 20th line from the bottom, for "two hundred," read two hundred and sixty.
Page 302, 15th line from the bottom, for "to which," read for which.
Page 312, 7th line from the top. for "*ventricoso*," read *ventricosa*.
Page 331, 18th line from the bottom, for "amulacra," read ambulacra.
Page 336, 25th line from the bottom, for "apendages," read appendages.
Page 350, 14th line from the top, and 12th line from the bottom; and also page 352, 3d line from the top, for auxillary," read axillary.
Page 379, 22d line from the bottom, for "speciman." read specimen.
Page 451, 18th line from the top, for "specics," read species.
Page 529, 14th line from the bottom, for "semi-cirular," read semi-circular.
Page 552, 2d line from the bottom, for "rnal," read anal.
Page 555, 3d line from the bottom, for "*Platycrin?*" read *Platycrinus*.
Page 608, 7th and 9th line from the top, for "*Temnochilus*," read *Temnocheilus*.

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A side view of body, arms, and a part of the column.

Fig. 2. ZEACRINUS SCOBINA 426
A side view of body and arms, with a few joints of the column attached.

Fig. 3. SCAPHIOCRINUS FISCELLUS 424
A side view of body and arms (the latter being partly broken), enlarged to about two diameters.

Fig. 4. ZEACRINUS *(sp. undet.)* ....
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5 *a.* A side view of body and arms, nat. size.
5 *b.* The same, enlarged.

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Fig. 8. SCAPHIOCRINUS NANUS 423
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5 *b.* The same, enlarged.

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A side view of body and arms, with the upper part of the ventral prolongation seen projecting slightly beyond the arms above

Fig. 10. SCAPHIOCRINUS CLIO 408
Side view of body and arms, as well as of the ventral prolongation, though the latter is not in a condition to show clearly the outline of its plates.

Fig. 11. ZEACRINUS LYRA 432
11 *a.* A side view of body and arms.
11 *b.* A posterior view of another specimen of same, showing body, arms, and the base of the ventral prolongation.

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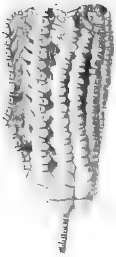
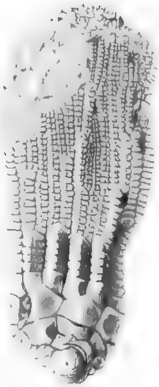
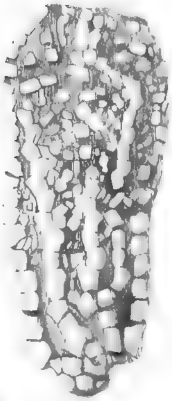
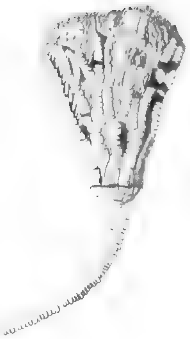
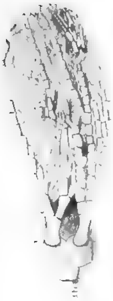
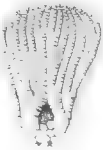
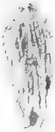
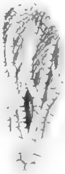
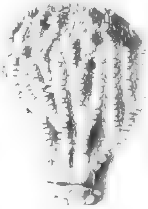
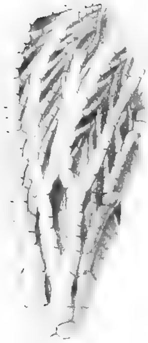
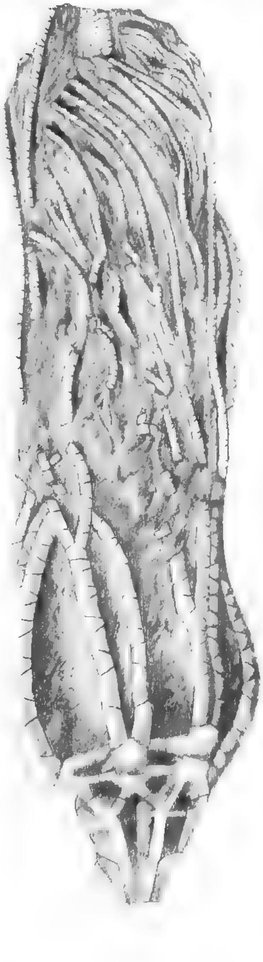
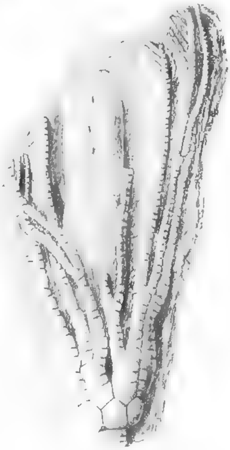
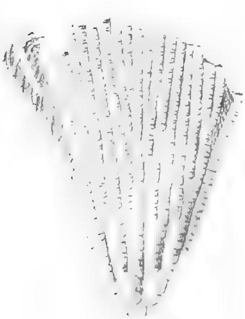
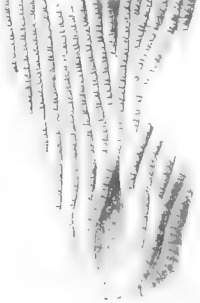

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PLATE II

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Fig. 1. CALCEOCRINUS WACHSMUTHI...446
1 *a.* Posterior view showing the body and some of the arms, with also a portion of the column attached. The natural posture of this little Crinoid would doubtless be with the base above and the arms pendent.
1 *b.* An anterior view of the same.

Fig. 2. ERISOCRINUS WHITEI...448
2 *a.* A side view of the much depressed body, and portions of the arms.
2 *b.* View of the under side of the body.

Fig. 3. ERISOCRINUS ANTIQUUS...447
3 *a.* A side view of body and arms, the latter being folded together.
3 *b.* The underside of the body, enlarged.

Fig. 4. NIPTEROCRINUS WACHSMUTHI...435
4 *a.* A side view of body and arms, with a portion of the column; the body plates being somewhat displaced.

Fig. 5. SYNBATHOCRINUS WACHSMUTHI...437
5 *a.* Posterior view of the body and the lower part of the arms, with a portion of the column attached. (The entire length of the arms is about five times that of the portions seen here.)
5 *b.* Another specimen, with a part of the arms removed so as to show the long, slender ventral tube, somewhat crushed within.
5 *c.* Parts of the arms and a portion of the ventral tube, enlarged, to show the latter more distinctly.
5 *d.* Two of the arm joints, with the minute marginal pieces folded together so as to cover the ambulacral furrow; all enlarged.
5 *e.* An end view of the same.

Fig. 6. SYNBATHOCRINUS BREVIS...439
Showing body and arms complete, with a part of the column.

Fig. 7. SCAPHIOCRINUS PENICILLUS...414
7 *a.* A posterior view of the body and arms.
7 *b.* A side view of another specimen.

Fig. 8. SCAPHIOCRINUS JUVENIS...417
8 *a.* A posterior view of body and arms, with a part of the column.
8 *b.* Anterior view of the same.

Fig. 9. SCAPHIOCRINUS MACRODACTYLUS...415
A view of body, arms, and a portion of the column.

Fig. 10. SCAPHIOCRINUS SCALARIS...421
Posterior view of a specimen showing the body, arms and pinnulæ, nearly entire, and a part of the column.

Fig. 11. SCAPHIOCRINUS STRIATUS...418
11 *a.* A posterior view of the body.
11 *b.* View of the under side of same.

Fig. 12. POTERIOCRINITES PERPLEXUS...40.
A posterior view of body, arms, and a part of the column and ventral prolongation.

Fig. 13. SCAPHIOCRINUS TETHYS...410
A side view of body, arms, and a part of the column.

Fig. 14. CYATHOCRINITES FRAGILIS...401
A view of the body and parts of the arms.

Fig. 15. CYATHOCRINITES TENUIDACTYLUS...403
A view of body, arms and a part of the column.

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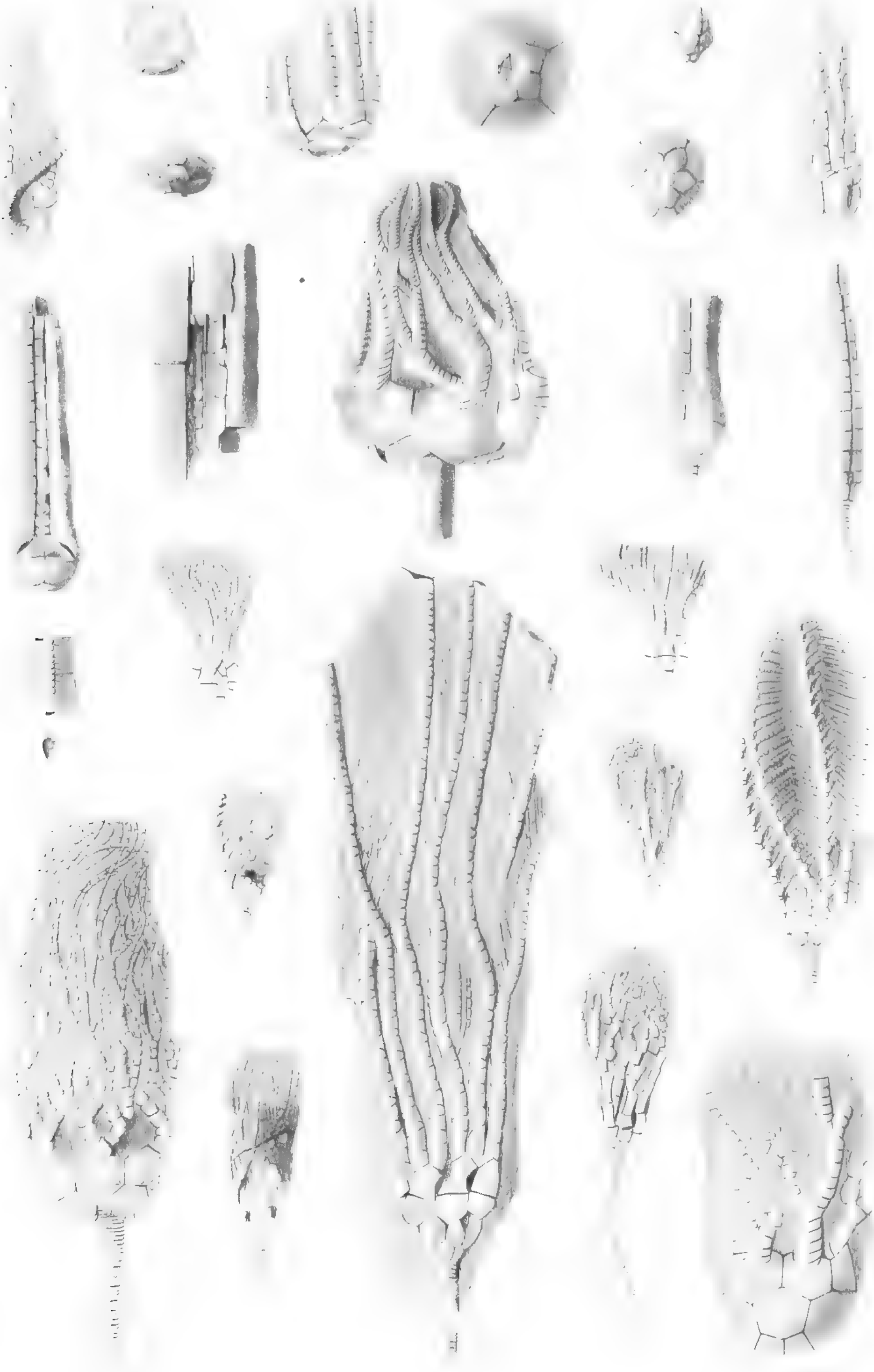

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PLATE III.

PAGE.

Fig. 1. DICHOCRINUS LINEATUS..440

1 *a*. Anterior side view of body.

1 *b*. View of under side of same.

1 *c*. Posterior view of same.

Fig. 2. DICHOCRINUS PISUM..441

2 *a*. Posterior side view of body.

2 *b*. Anterior side view of same.

2 *c*. View of under side of same

Fig. 3. PLATYCRINITES HALLI..454

3 *a*. Anterior side view of body and a part of the twisted column. The appearance of little nodes on the base is not natural, but merely small, thickened protuberances, formed by the borings of some small parasite. They also occur on some parts of the *first* radial pieces, as well as on some joints of the column.

3 *b*. View of the upper side of the vault of same specimen the small lateral opening surrounded by small pieces is scarcely seen at *aa*.

3 *c*. Dorsal or outer view of a portion of an arm (from another specimen), enlarged three diameters, and showing the little sharp, projecting processes on each side

3 *d*. A side view of same

Fig. 4. PLATYCRINITES TENUIBRACHIATUS..450

4 *a*. Side view of a somewhat crushed specimen, showing body and arms.

4 *b*. Same view of another specimen, with the body not compressed. (In both of these figures the surface markings are represented as too much broken up into little nodes, instead of forming little irregular, somewhat interrupted ridges, parallel to the margins of the body plates.

4 *c*. A portion of one of the arms enlarged three diameters dorsal or outer view,

4 *d*. A side view of same.

Fig. 5. PLATYCRINITES PLANUS..452

5 *a*. Side view of body and arms, with a piece of the column.

5 *b*. Dorsal or outer side of a part of one of the arms (near the middle), enlarged three diameters.

5 *c*. A side view of same.

Fig. 6. PLATYCRINITES BURLINGTONENSIS..452

6 *a*. Side view of body and arms, with a piece of the column.

6 *b*. Side view of a piece of one of the arms (near the middle), enlarged three diameters.

6 *c*. Dorsal view of same.

Fig. 7. PLATYCRINITES INCOMPTUS..459

View of under side of body and arm bases.

Fig. 8. PLATYCRINITES ÆQUALIS..456

8 *a*. Side view of a nearly perfect specimen, showing body and arms.

8 *b*. A part of one of the arms from near the middle dorsal side, enlarged about three diameters, and showing the peculiar geniculated, and sometimes even divided character of the piece, by which they pass at some places into three or four ranges.

8 *c*. Side view of same, showing the flattened or slightly concave character of the sides of the arms.

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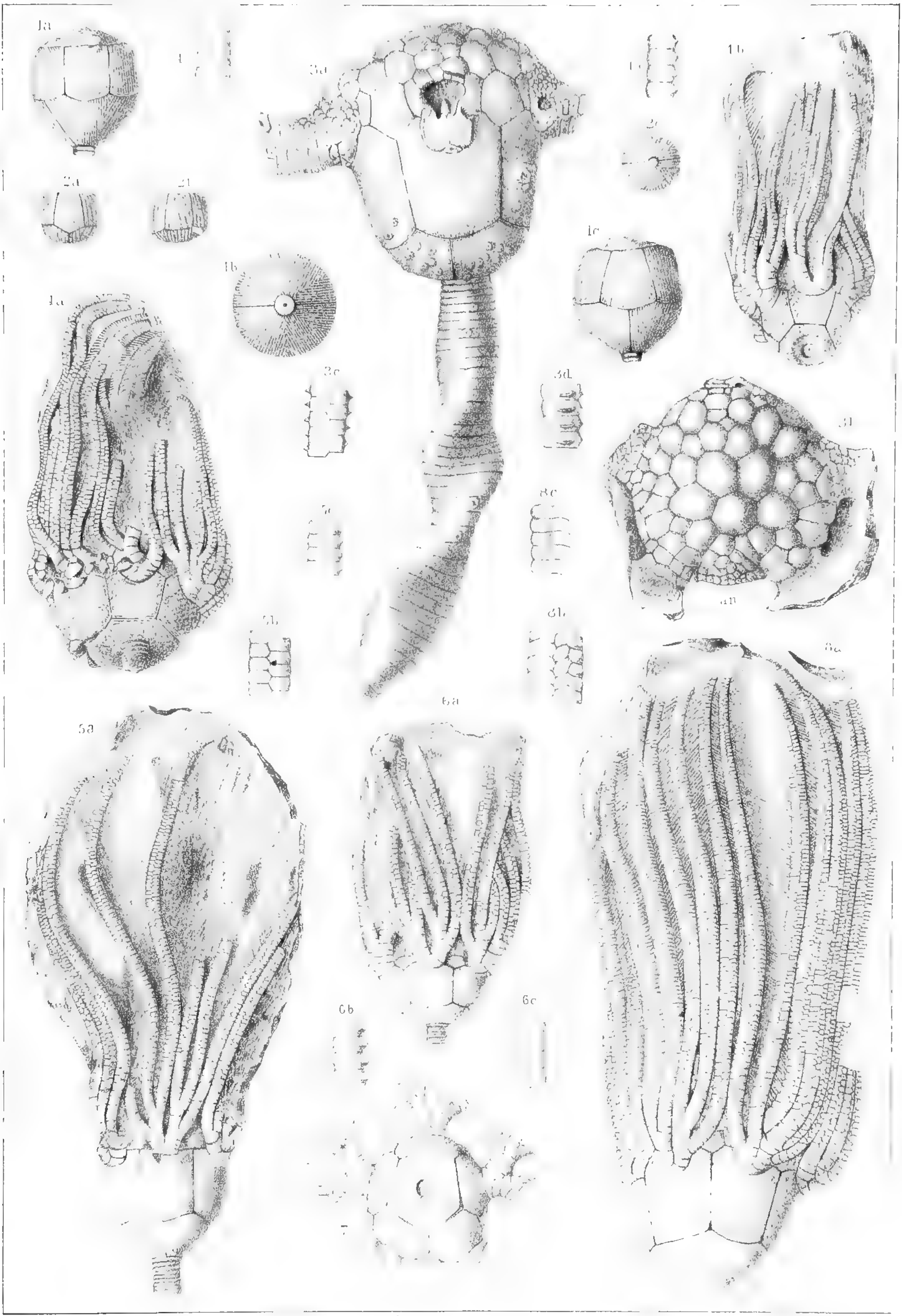

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PLATE IV.

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Fig. 1 Taxocrinus Thiemei 399

Fig. 2. Actinocrinites sculptus......... 343

Showing the arms.

Fig. 3. Batocrinus Verneuilianus 379

Specimen showing column and ventral tube.

Fig. 4. Same. (Showing the arms.)

Fig. 5. Barycrinus Sculptilis 401

Basal view.

Fig 6. Goniasteroidocrinus obovatus.. 391

Side view of body placed a little obliquely, so as to show the concavity of the middle of the under side, the lowest range of pieces seen, however, being the subradials, the basal pieces being deeply sunken in the concavity. The true arm openings are seen at *a a*, and the false arm openings at *fa fa*.

6 *a*. End view of same specimen.

Fig. 7 Proboscis of Pot. dilatatus?........................ .. ..

Fig. 8. Nipterocrinus arboreus............... 436

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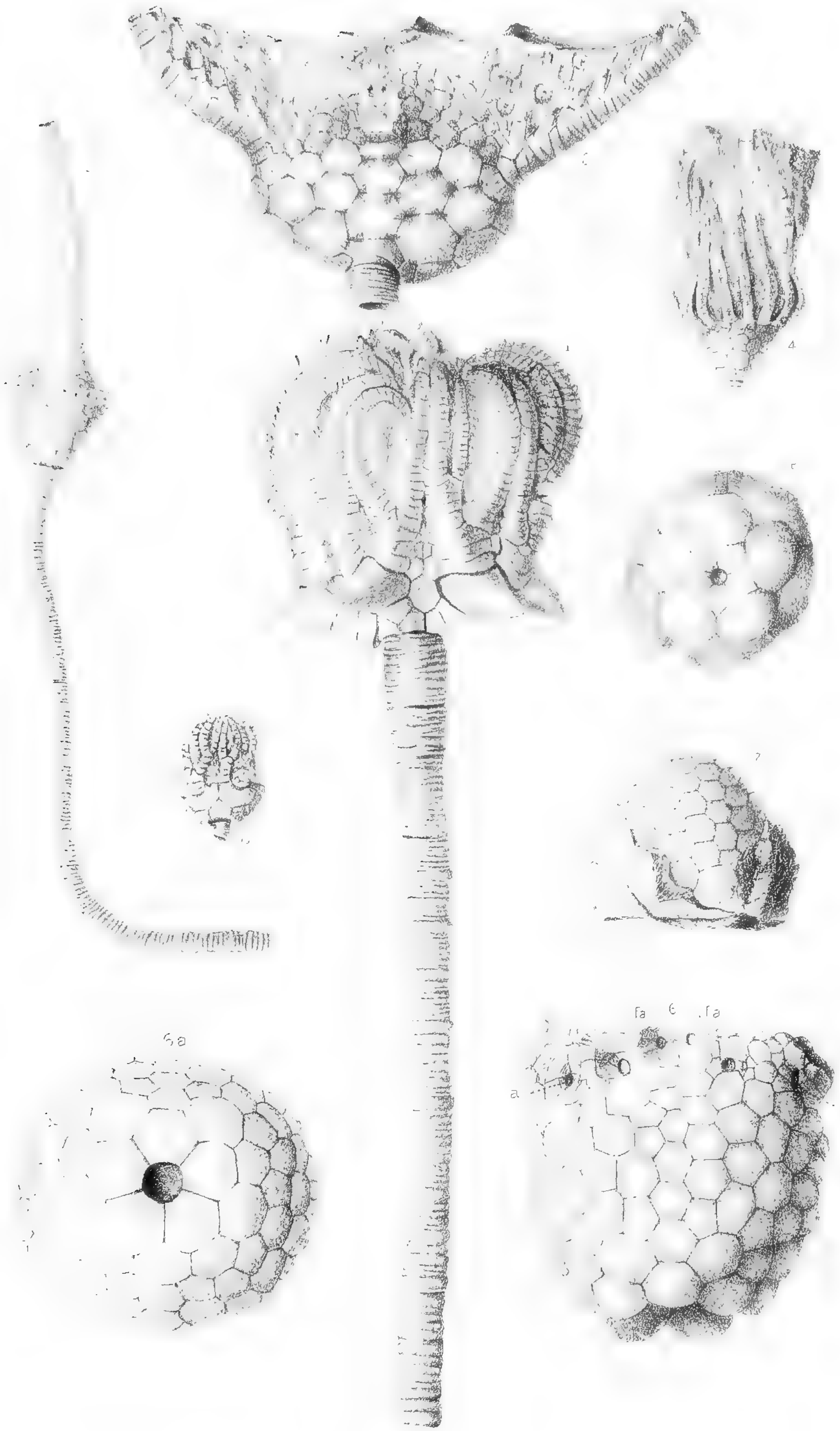

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PLATE V.

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1 *a.* Anterior side view of body and a part of the ventral tube.
1 *b.* Posterior view of same.

Fig. 2. Batocrinus quasillus.......................................369
2 *a.* Anterior side view of body and the base of the ventral tube.
2 *b.* Posterior side view of same.

Fig. 3. Batocrinus (Eretmocr ?) neglectus.......................................377
3 *a.* Anterior side view of body.
3 *b.* Posterior side view of another specimen.

Fig. 4. Batocrinus Christyi.......................................379
4 *a.* Posterior side view of a small specimen, showing body, arms, and most of the ventral tube entire.
4 *b.* A large specimen with the arms removed, showing body, most of the ventral tube, and a portion of the column.
4 *c.* Two joints of one of the pinnulæ, much enlarged, to show a row of minute marginal pieces on each side of the ambulacral furrow, which they cover when closed together.
4 *d.* An end view of a joint of one of the pinnulæ, showing the comparatively large cavity of the ambulacral furrow, covered by the closed marginal pieces.

Fig. 5. Batocrinus pyriformis.......................................375
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Fig. 6. Batocrinus trochiscus.......................................372
6 *a.* A side view of a specimen showing the body, with the arms and ventral tube broken away.
6 *b.* A view of the under side of the same.

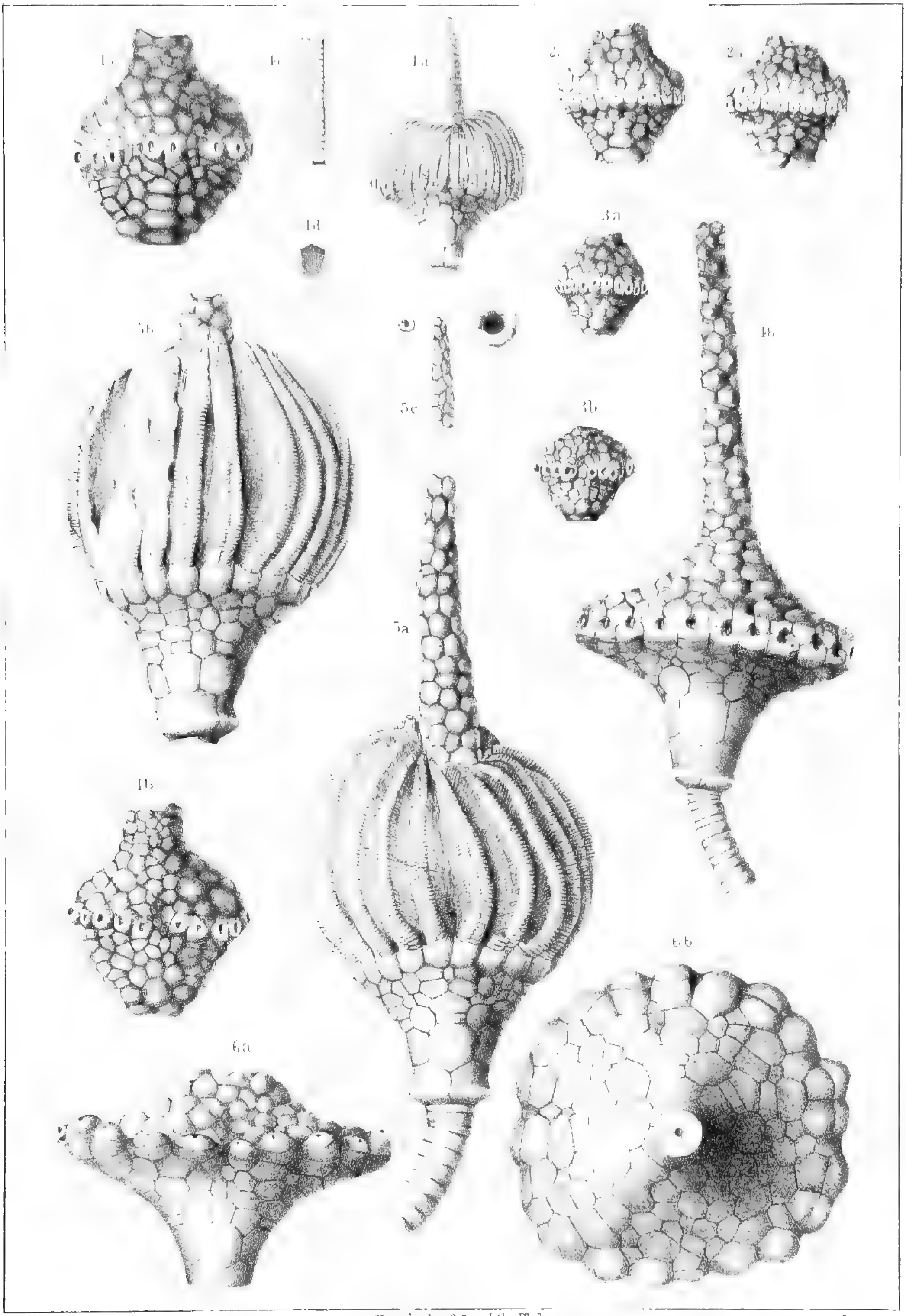

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PLATE VI.

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Fig. 1. Megistocrinus (Saccocrinus) Whitei 397

1 *a.* View of anal side of the body, with the arms removed, (one of the type specimens.)

1 *b.* Anterior view of same.

1 *c.* A smaller specimen of same, showing body and arms.

Fig. 2. Dorycrinus unicornis 383

2 *a.* A side view of a specimen showing body and arms, a part of the latter being removed so as to show one side of the vault with its central spine.

2 *b.* Another view of the same specimen.

2 *c.* An enlarged diagram of two of the arm bases and the brachial piece on which they rest, showing the manner in which two arms spring directly from each last brachial piece, without imparting to it the character of an axillary piece proper.

Fig. 3. Amphoracrinus (sp. ?).................. 386

This is an outline sketch of an English specimen of a typical *Amphoracrinus*, with the ventral tube or proboscis entire. From Cumberland's Reliquiæ Conservatæ, pl c.

Fig. 4. Dorycrinus canaliculatus... 381

4 *a.* View of anal side of body.

4 *b.* Anterior view of same.

Fig. 5. Amphoracrinus ? spinobrachiatus...389

5 *a.* Specimen with arms attached, placed so as to show an oblique view of the concave under side of the body.

5 *b.* A view of the under side of same.

Fig. 6. Amphoracrinus divergens, var. multiramosus 388

6 *a.* Anal and oblique under view of body and arms, somewhat compressed. The probosciform ventral tube is mainly hidden by some arms, but the spines crowding its summit are seen at (*s.*)

6 *b.* Side view of the proboscis broken from another specimen, showing its spines and its minute opening at (*o.*)

6 *c.* View of the top of the same, as seen from above, with the minute opening seen in the middle surrounded by very small pieces.

Fig. 7. Megistocrinus parvirostris................. 396

An anal view of body.

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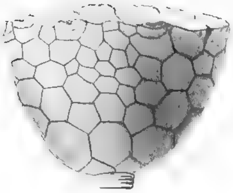

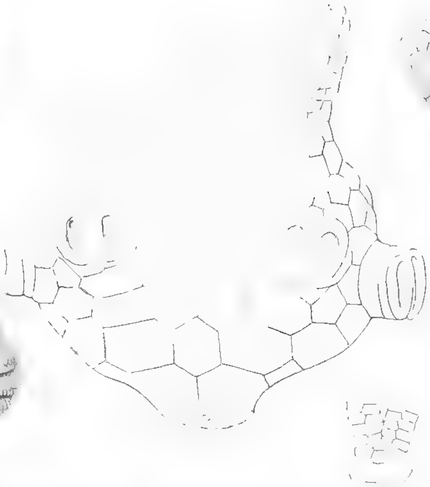

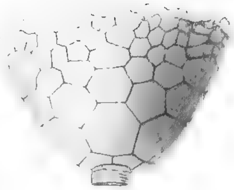

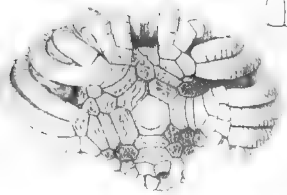

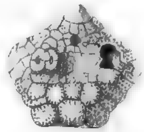

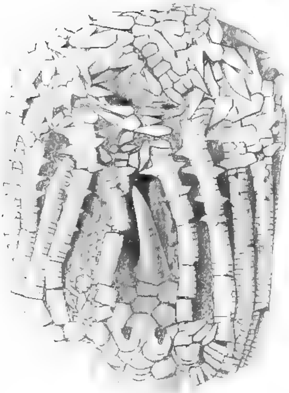

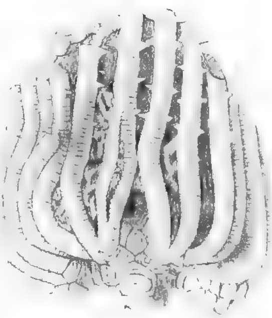

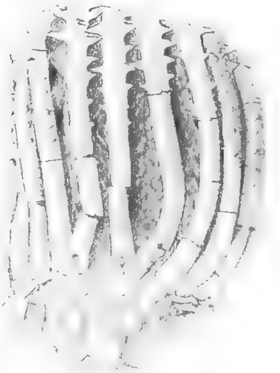

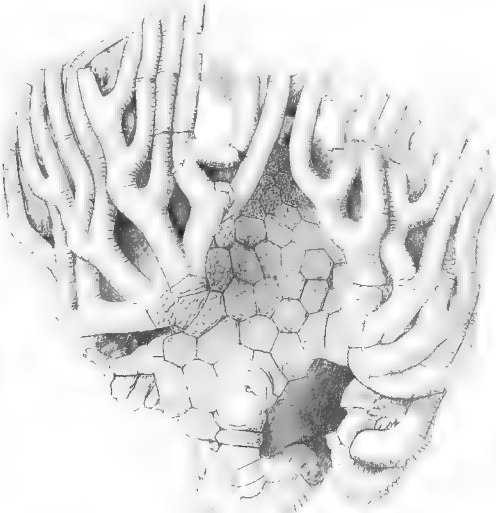

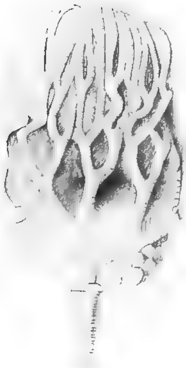

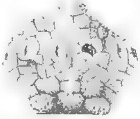

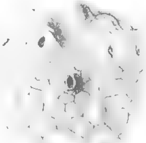

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PLATE VII.

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Fig. 1. STROTOCRINUS (PHYSETOCRINUS) ASPER.. 351

1 *a*. A posterior lateral view of the body and some of the arm-bases, with the vault and its small subcentral opening, margined on one side by a slightly projecting lip.

1 *b*. An anterior view of same.

Fig. 2. STROTOCRINUS LIRATUS.. 355

2 *a*. A side view of the body and long recurved ventral tube, with a short piece of the column. The body is somewhat distorted by accidental pressure, and the ornamentation of its plates is nearly obliterated by weathering.

2 *b*. A side view of the recurved part of the ventral tube, showing, by the larger sizes of its pieces on the convex side of the curve, that this difference in the sizes of these pieces on the two sides is the cause of the curve, and not the flexibility of the tube. The end of the tube is broken, and not complete.

2 *c*. A side view of the body and vault of another specimen, the surface markings of which are well preserved.

Fig. 3. STROTOCRINUS (sp. undetermined.)..

This figure shows the body split longitudinally, so as to expose the large internal convoluted organ in place, and nearly filling the whole interior cavity. It is incrusted with siliceous matter so as to hide its structure. At the point on the right marked (*a*) its outer turn is in contact with the outer wall, and seems not to have extended lower on that side, that being apparently the point intersected by the oblique spiral ridge bounding the lower margin of the organ as it ascended spirally. One of the radiating canals extending out to the arm openings from the top of the convoluted organ, under the vault, is seen on the left at (arm.)

Fig. 4 *a*. A part of the column of *Strotocrinus ægilops*, showing curious external processes apparently designed to strengthen the whole, without destroying its flexibility.

4 *b*. A portion of the same, enlarged.

Fig. 5. STROTOCRINUS ECTYPUS 353

5 *a*. Side view of body and base of ventral tube.

5 Posterior view of same.

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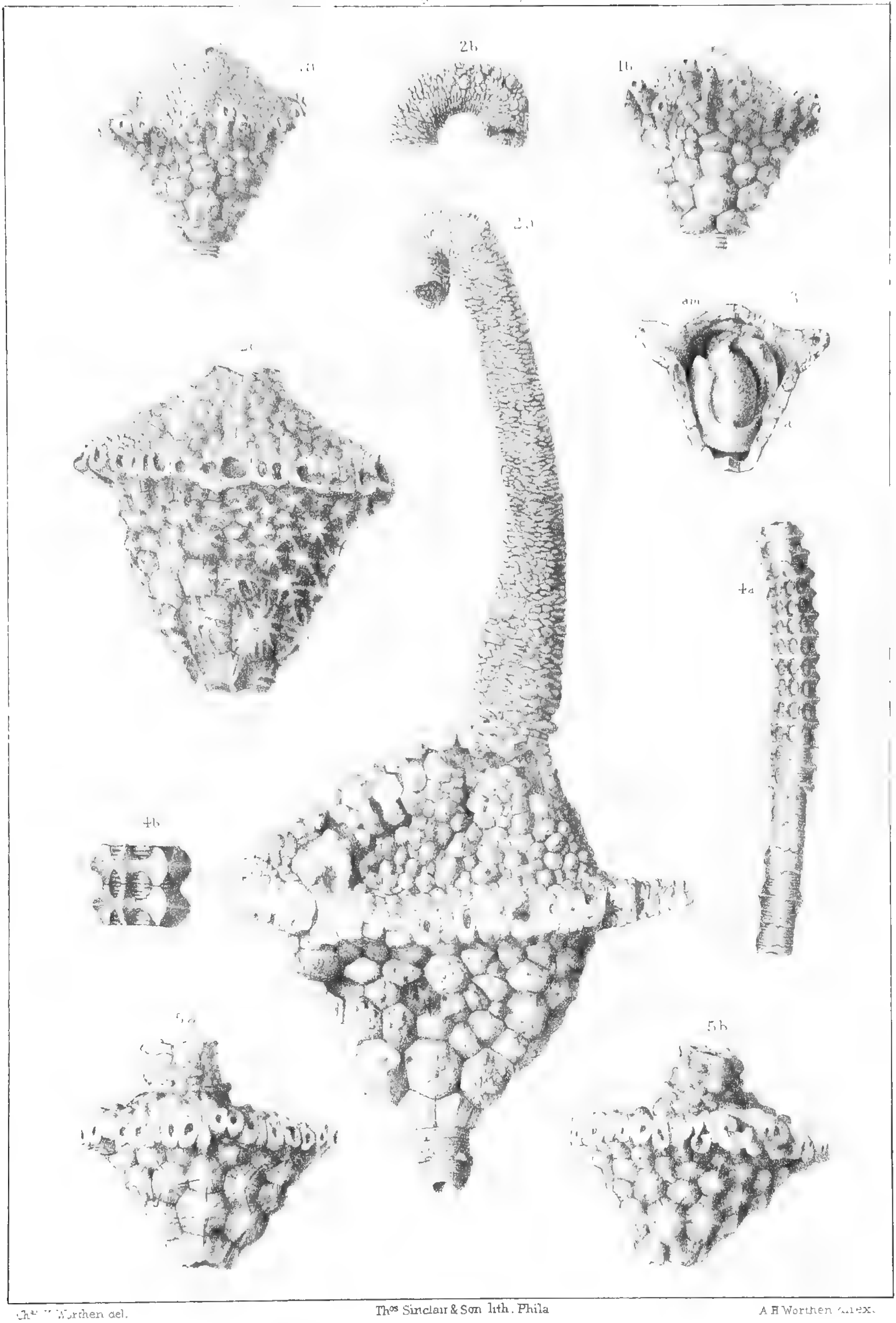

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PLATE VIII.

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Fig. 1. ACTINOCRINITES? LONGUS 345

1 *a.* Side view of body and vault, the ventral tube being broken away.

1 *b.* Another view of same.

Fig. 2. ACTINOCRINITES DELICATUS..343

A posterior lateral view of body and arms, with the broken end of the ventral tube projecting above.

Fig. 2* ACTINOCRINITES PENICILLUS..342

(Side view of body and arms,)

Fig. 3. STROTOCRINUS? ASPERRIMUS..349

3 *a.* A side view of the body and vault, with the base of the ventral tube and broken bases of the rays.

3 *b.* Another view of same.

Fig. 4. STROTOCRINUS PERUMBROSUS..357

4 *a.* A view of the flat vault, with broken ends of the rays; also showing the nearly central opening directed obliquely outward away from the anal side.

4 *b.* A view of another specimen turned obliquely upward so as to show the under side of the spreading rays, and the manner in which the brachial and intermediate pieces unite laterally so as to form the great expansion, as well as the manner in which the free arms are given off alternately on each side of the rays. Only three of the main divisions of the rays are seen entire out to last arm-base; all the others, with their arms, being broken away. The remaining arms are folded over upon the vault so as only to show their bases.

Fig. 5. STROTOCRINUS UMBROSUS 360

A lateral view of body (excepting the base, which is broken away,) and arms.

Fig. 6. PENTREMITES (CODONITES) GRACILIS..467

6 *a.* A side view of the body somewhat enlarged, the so-called pore pieces on one side of one of the pseudo ambulacra, at (*a*) being removed.

6 *b.* The central parts and openings of the summit enlarged, and in some parts a little restored.

6 *c.* One of the pseudo ambulacra, enlarged.

Fig. 7. PENTREMITES BURLINGTONENSIS..461

7 *a.* An upper view of a large specimen. (Some of the parts restored from a smaller specimen.)

7 *b.* A side view of the same. (Some individuals have the body a little more prominent below than that figured.)

GEOLOGICAL SURVEY OF ILLINOIS

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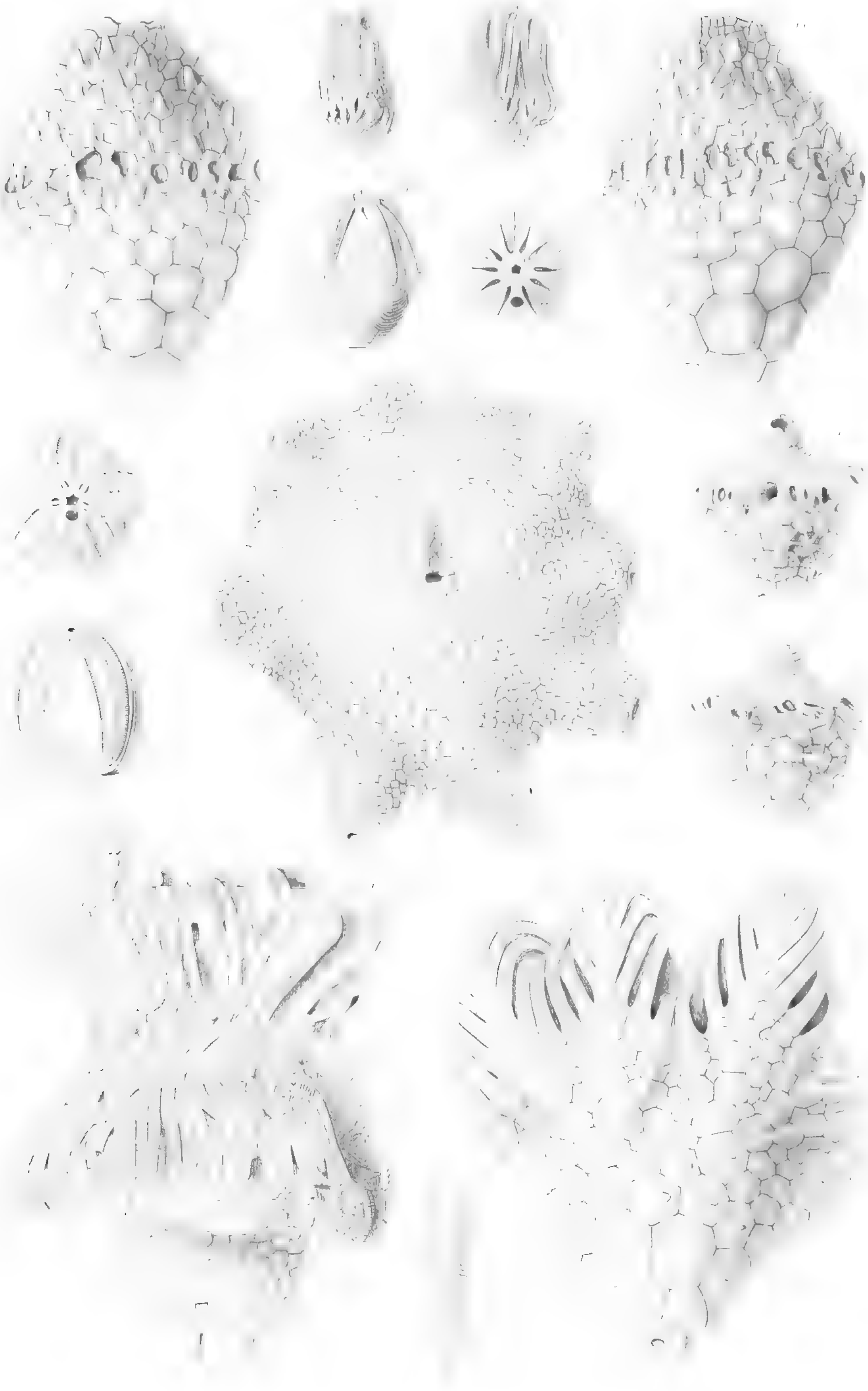

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PLATE IX.

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Fig. 1. GRANATOCRINUS MELONOIDES 468

a. Side view, enlarged about one and a half diameters.

1 *b.* Under view of same.

Fig. 2. GRANATOCRINUS NORWOODI 473

2 *a.* View of summit enlarged about two diameters; *i r*, *i r*, *i r*, *i r*, representing the interradial pieces, each one of which shows externally a single pore; *a o* the anal opening with its valve removed; *a n p*, anal piece; *v*, the small vault covering the central opening, and *a m*, *a m*, *a m*, *a m*, the pseudo-ambulacra, with the ambulacral furrow extending along the middle of each and passing under the little vault into the central opening.

2 *b.* The summit of another specimen of same, enlarged two diameters, and showing the valve-like piece *a v*, closing the anal opening in place.

2 *c.* A cast of the interior of the summit of another specimen, enlarged about two diameters. The forms of the interradial, anal, and the upper ends of the lancet piecess, *l l l l*, are distinctly defined by sharp, raised lines along the suture. *o a* represents the cast of the anal opening; *o*, that of the central opening; *p p p p p* represent the casts of the pores passing through the interradial pieces, *i r i r i r i r*, and show how these pores each divide into two within.

Fig. 3. GRANATOCRINUS NEGLECTUS 471

3 *a.* View of summit enlarged two diameters, with the central and anal openings uncovered. In this there are two distinct, very small pores to each interradial piece, at the points marked *p p*, and these pores do not pierce the interradials, as in *G. Norwoodi*, but pass in, one on each side of these pieces.

3 *b.* Side view of same species, enlarged to two diameters,

Fig. 4. GRANATOCRINUS PISUM 470

4 *a.* Side view, enlarged about two diameters.

4 *b.* View of upper side of same, with central and anal openings uncovered.

Fig. 5. CODONITES STELLIFORMIS 464

Upper view of a small specimen, enlarged to a somewhat larger size than that of a large individual of this species. At *v*, the small vault pieces are seen covering the central opening, and also extending out so as to cover the ambulacral furrows, *a m a m*, which can be clearly seen to pass in under this covering, as at *a*. The anal opening is seen at *a n*, while the so-called ovarian pores of the *Pentremites* are represented by the slit-like openings, *s s*, which connect with the compressed tubes within, under the pseudo-ambulacra.

5 *a.* A side view of a small specimen; showing the part under the base that has been, by some, supposed to be in the *Pentremites* the true basal pieces, to be really only some six of the upper joints of the column, anchylosed together, and to the base.

5 *b.* An under view of the sub-basal part.

Fig. 6. BATOCRINUS SECURIS 328

6 *a.* View of a specimen with one side broken away, so as to show a part of the reticulated, convoluted internal organ in position; the whole being magnified one-half diameter larger than natural size.

6 *b.* A part of the reticulated internal organ, more highly magnified.

Fig. 7. ACTINOCRINITES PROBOSCIDIALIS 330

7 *a.* A specimen with one side of the vault broken away, so as to show the convoluted organ, *s*, and the delicate ambulacral canals, *a m*, *a m*, extending outward and downward under the vault from the top of the convoluted digestive sack to the arm openings, *o o*, the whole being magnified one-half diameter larger than the natural size.

7 *b.* One of these canals and its branches, more highly magnified.

PLATE IX—*Continued.*

PAGE.

7 *c.* A portion of one of these canals still more highly magnified, and apparently covered over by plates, so as to form a tube. This character of covering pieces was not *clearly* seen as represented in this figure, but some remaining minute pieces were seen at one point, indicating such a structure.

Fig. 8 *a.* The digestive sack, from a species nearly related to *Act. proboscidialis*, though not positively known to belong to that species. It is magnified about four diameters.

8 *b.* A portion of the same, more highly magnified.

Fig. 9. ACTINOCRINITES (?) ORNATUS 332

An internal cast of the vault; showing the ambulacral canals, *a m*, converging to a point a little in advance of the anal opening, *a n*, which is made to appear larger than natural by the manner in which its cast is broken. The casts of the ambulacral canals are seen to bifurcate, so as to send a branch to each arm opening, *(a a a a a)*, etc.

Fig. 10. An internal view of the vault of another specimen of the same species; showing the large furrows, *f f*, for the ambulacral canals, converging from the arm openings *a a a a a*, etc., to a point in advance of the anal opening, *a n*. Between the large furrows *f f*, the partitions, *l l*, have their projecting edges partly covering the furrows.

Fig. 11. BATOCRINUS LONGIROSTRIS ....

A specimen of the body, with one side removed to show a curious inner wall, sometimes secreted in old specimens.

Fig. 12. BATOCRINUS VERNEUILIANUS 328

12 *a.* Body with one side removed to show the internal convoluted organ in place, with its external spiral ridge, the whole magnified one-half diameter beyond the natural size.

12 *b.* An inferior end view of this organ; showing the commencement of the spiral ridge at the lower end, magnified as above.

12 *c.* A fragment of the same, magnified more highly so as to appear as it made up of minute plates. As seen still more highly magnified, however, these look like crystals, as represented by fig. 12 *a*, consequently they *may* be minute crystals, deposited in an open net-work.

Fig. 13. CYATHOCRINITES IOWENSIS 325

View of upper side, showing the small vault, *v*, covering the central opening, and the ambulacral canals, *a m c*, *a m c*, passing in from the arm-bases under the vault into the central opening—these canals being also themselves covered by small pieces *(a a)*. The interradials, *i i i*, only have a part of their full size exposed. The base of the proboscis or anal tube, is seen at *a n*. The whole magnified two diameters.

Fig. 14. CYATHOCRINITES MALVACEUS 325

A specimen with the vault removed, so as to leave the central opening *(h)* and the ambulacral canals *(a m, am.)* uncovered. Here the interradial pieces *(i i i i)* are seen to join together, so as to form, as it were a part of the vault. The openings *(x)* pass directly downward into the visceral cavity, and were probably for passage of the arm muscles. The base of the lateral anal tube, or proboscis is seen at *a n*. All magnified two diameters.

Fig. 15. ECHIDARIS (LEPIDOCIDARIS) SQUAMOSUS 478

15 *a.* A flattened specimen, showing apparently nearly half of two of the ambulacra, with the intervening interambulacral plates, and some of those of two other interambulacral spaces, a few of the primary spines, etc.; all natural size.

15 *b.* About half of one of the primary spines magnified two diameters.

15 *c.* A portion of same magnified four diameters, to show the minute longitudinal striae.

15 *d.* A longitudinal section of one of the ambulacral plates; showing the sloping side on the left, that was lapped by the edge of an adjacent plate, and that on the right, that lapped upon the contiguous plate on that side. Magnified two diameters.

15 *e* One of the larger ambulacral plates, showing the flattened part on the right, that was lapped upon by the marginal interambulacral plates. Magnified two diameters.

15 *f.* Two pieces of the jaws, found separated, but drawn as placed, together, as they probably belong; dorsal or outer view; natural size.

15 *g.* A side view of one of the same, showing one of the sides joined together in figure 15 *f*. The free side of each of these pieces as they are joined together is flat and smooth

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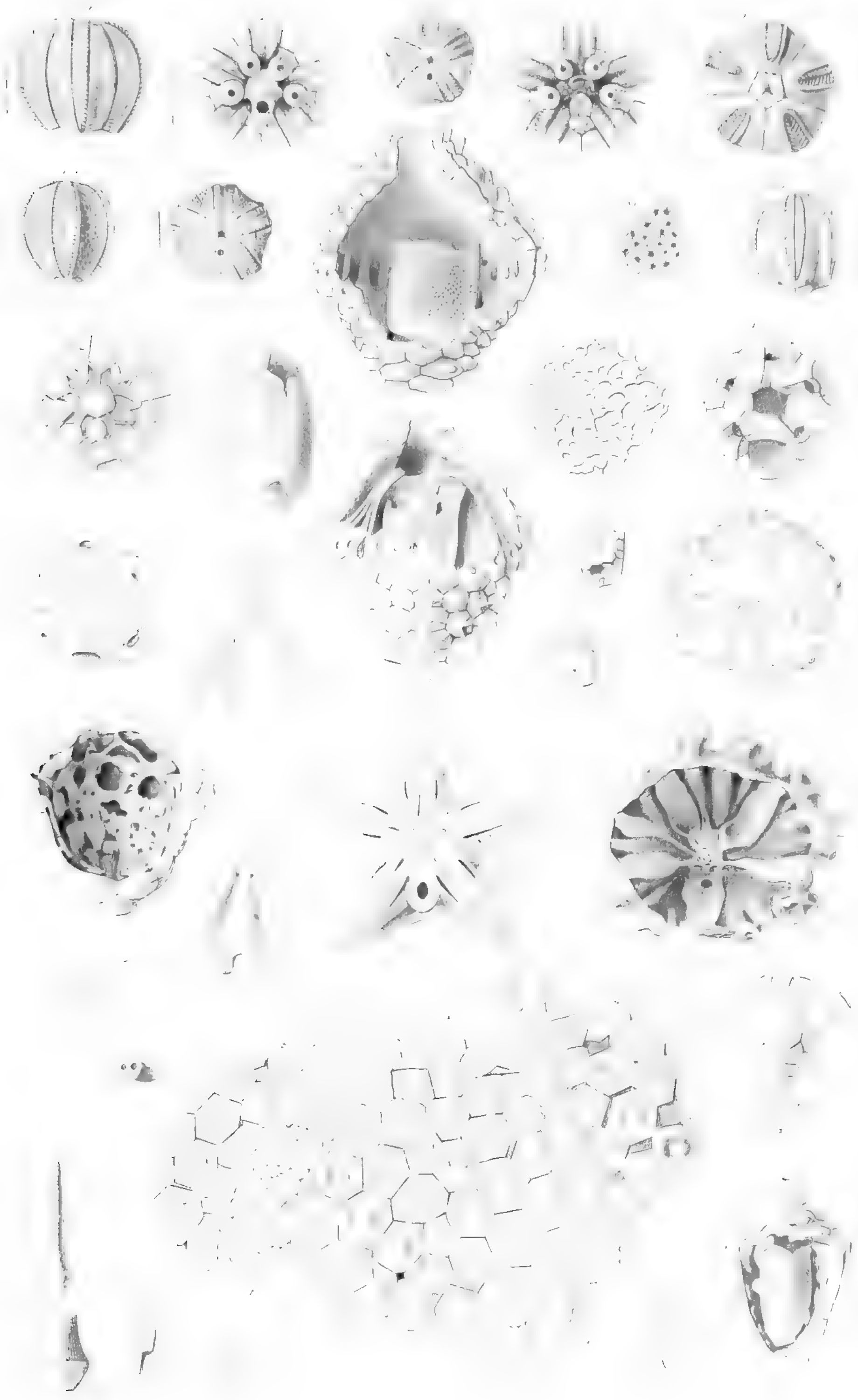

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PLATE X.

PAGE

Fig. 1. Onychaster? Barrisi 476

1 *a.* View of an imperfect specimen, natural size, showing the disc and two of the arms covered with the scaly outer integument, but not in a condition to show the individual scales distinctly. The middle arm of the figure has this integument removed, so as to show the articulated arm pieces.

1 *b.* Same specimen, enlarged

1 *c.* Two of the articulating arm pieces, still more enlarged.

1 *d.* An enlarged view of another specimen, consisting of the disc and portions of the arms; showing some of the scales of the disc at *s;* and where these have been removed, showing the stout oral pieces within, at *o p.*

Fig. 2. Palæchinus gracilis 473

A fragment consisting of a portion of one of the ambulacral series of pieces, with about half of one of the interambulacral series (showing its native breadth), and a few plates of another interambulacral series.

3. Dorycrinus Rœmeri 383

A posterior view of the body, showing the anal and arm openings. The space between the middle second anal piece and the opening may be occupied by more than one piece, but no sutures can be made out in the specimen.

Fig. 4. Dorycrinus intermedius 385

4 *a.* Posterior view of the body.

4 *b.* Anterior view of same.

Fig. 5. Batocrinus (Eretmocrinus) remibrachiatus 370

A side view of a specimen consisting of the body and arms, with a piece of the column, showing the remarkable flattened, paddle like form of the arms.

Fig. 6. Strotocrinus (Physetocrinus) dilatatus 363

A somewhat compressed specimen, consisting of body and arms, parts of the latter being broken off apparently above the middle.

Fig. 7. Agaricocrinus nodosus 397

7 *a.* Posterior view of the body and a piece of the column.

7 *b.* An under view of the same.

Fig. 8. Eretmocrinus coronatus. Hall sp. Supp. Geol. Iowa, p. 28..

8 and 8 *a.* Opposite sides of same specimen.

8 *b.* Basal view of same.

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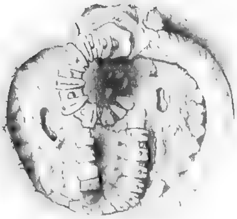
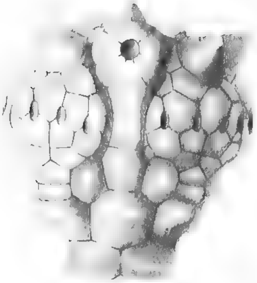
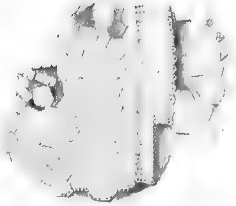

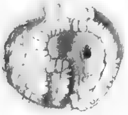
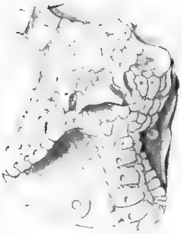
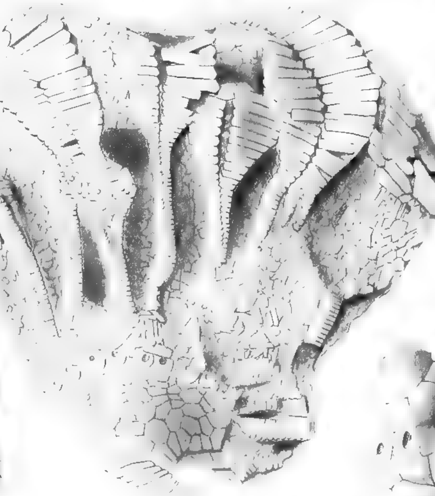
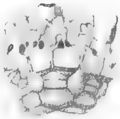
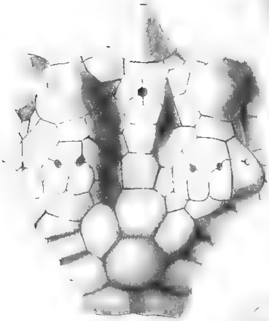
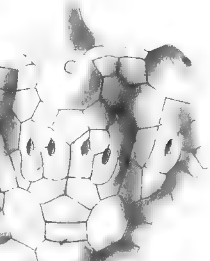
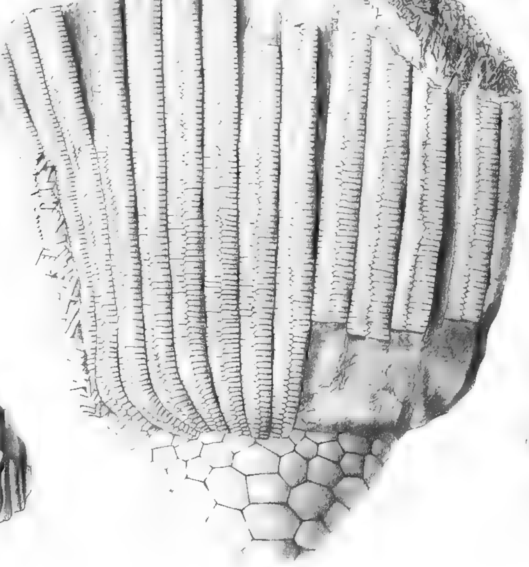
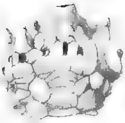
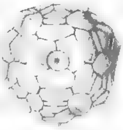
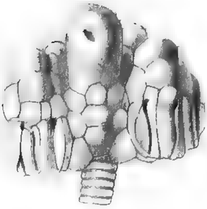
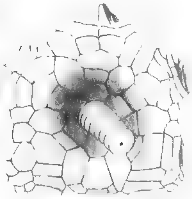

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PLATE XI.

PAGE.

Fig. 1 GONIASTEROIDOCRINUS TENUIRADIATUS 389

Under view of specimen, with body crushed; showing some of apparently the subradial pieces produced into short spines, and a part of the long, bifurcating false arms, extending out horizontally.

Fig. 2. PLATYCRINITES SUBSPINOSUS 452

2 and 2 *a*. Opposite sides of the body.

2 *b*. Basal view of same.

Fig. 3. OLIGOPORUS NOBILIS..476

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS

Burlington beds

ECHINODERMATA

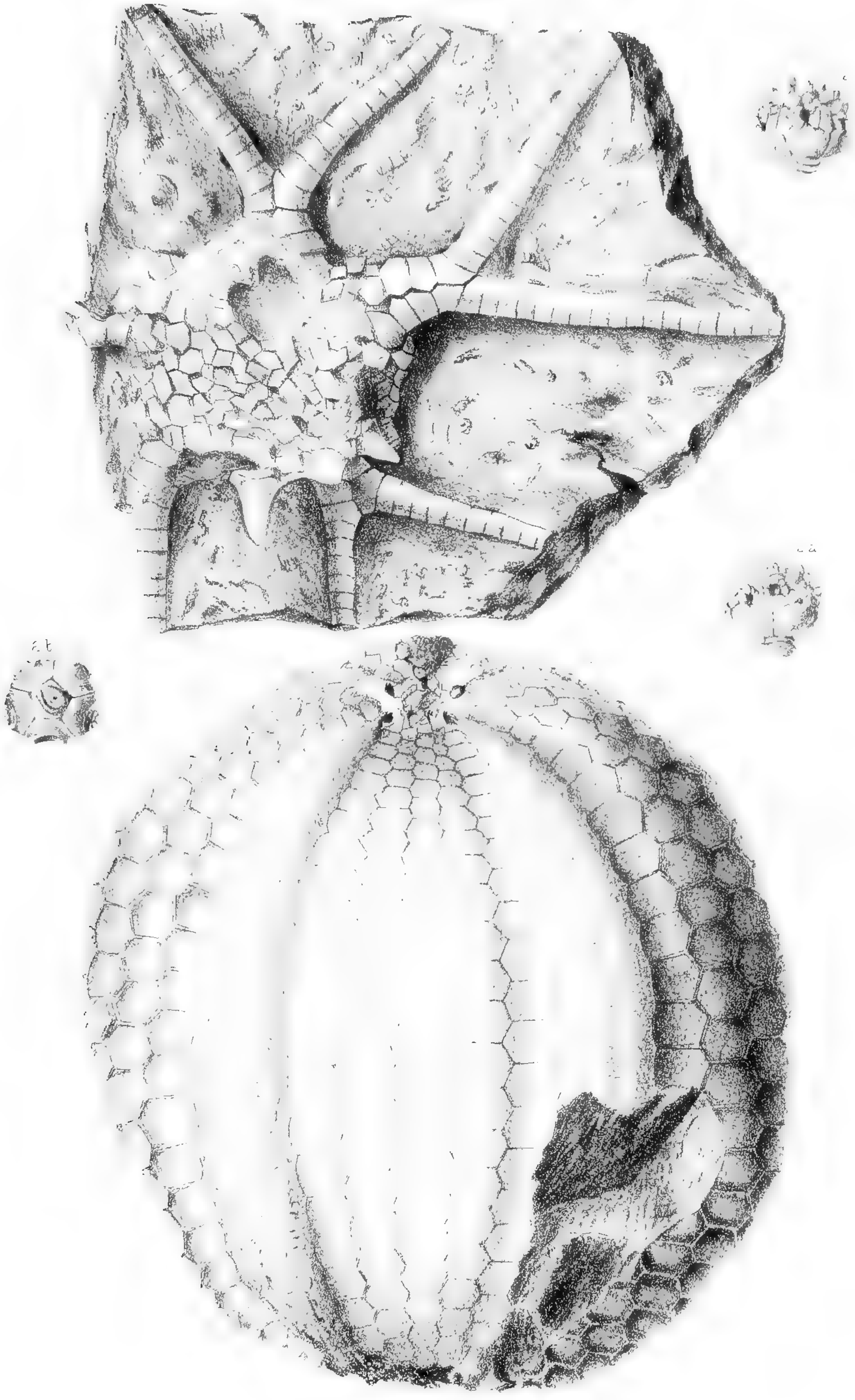

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PLATE XII.

PAGE.

Fig. 1. Agaricocrinus Whitfieldi 490
1 *a*. View of the top and lateral opening.
1 *b*. View of the base of the same specimen.

Fig. 2. Barycrinus magnificus 483
2 *a*. Side view.
2 *b*. View of the base.

Fig. 3. Barycrinus glomericus 485

Fig. 4. Cyathocrinites poterium 489

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS (Keokuk beds) CRINOIDEA

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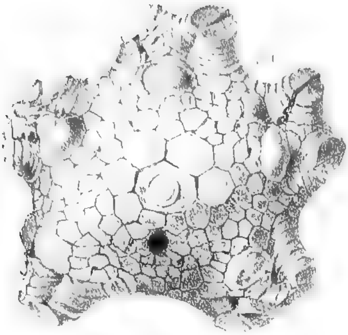

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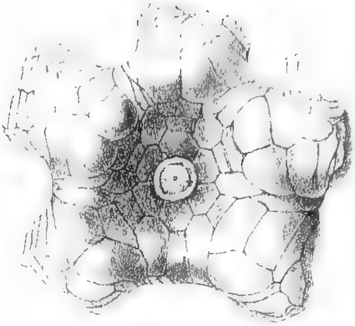

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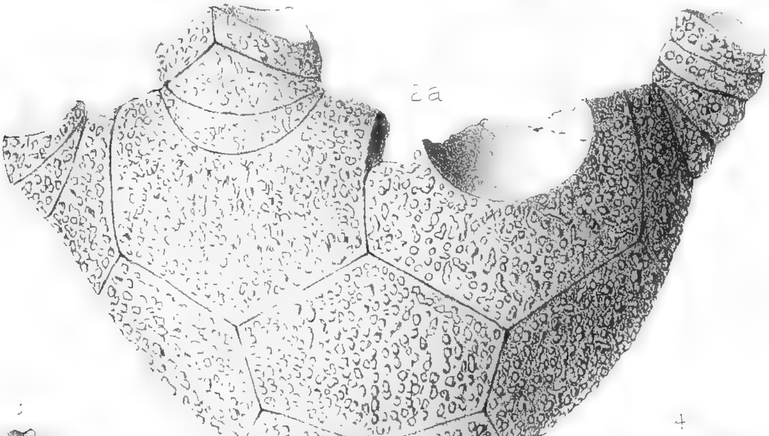

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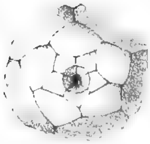

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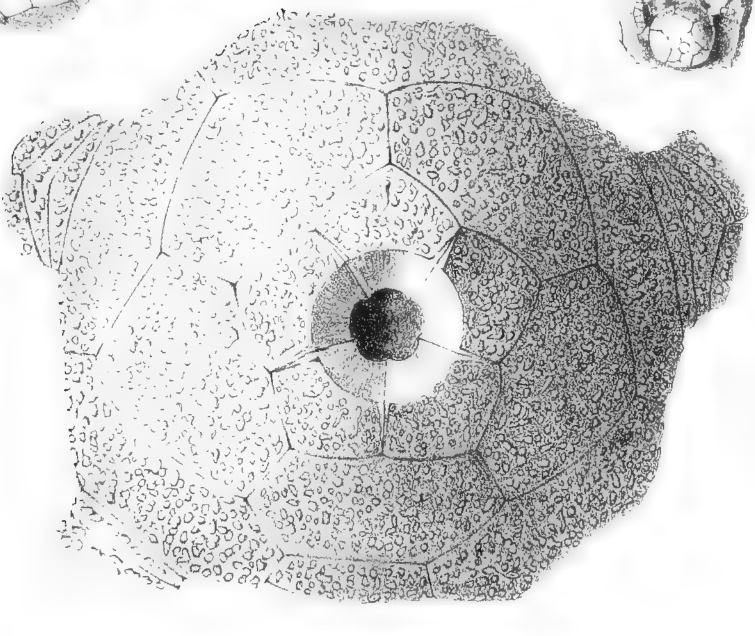

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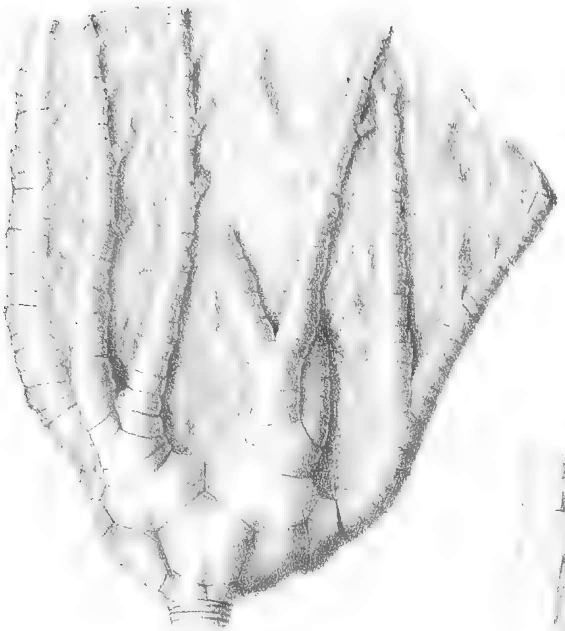
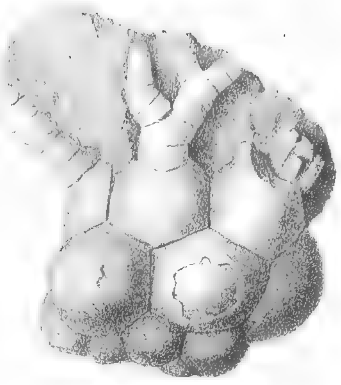
PLATE XIII.

			PAGE.
Fig	1.	BARYCRINUS HOVEYI	486
Fig	2	BARYCRINUS HERCULEUS	485
	2 *a* and *b*.	Opposite sides of two individuals of the same species.	
Fig	3	BARYCRINUS SUBTUMIDUS	487

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS Keokuk be CRINOIDEA





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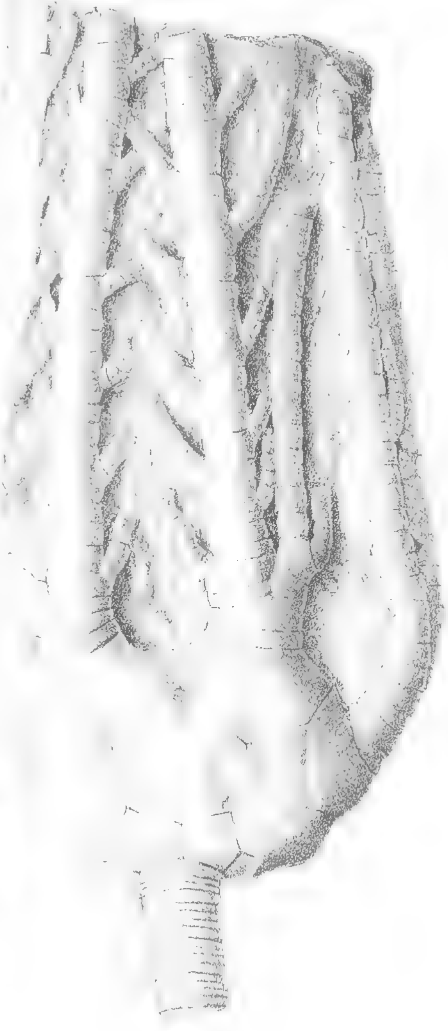

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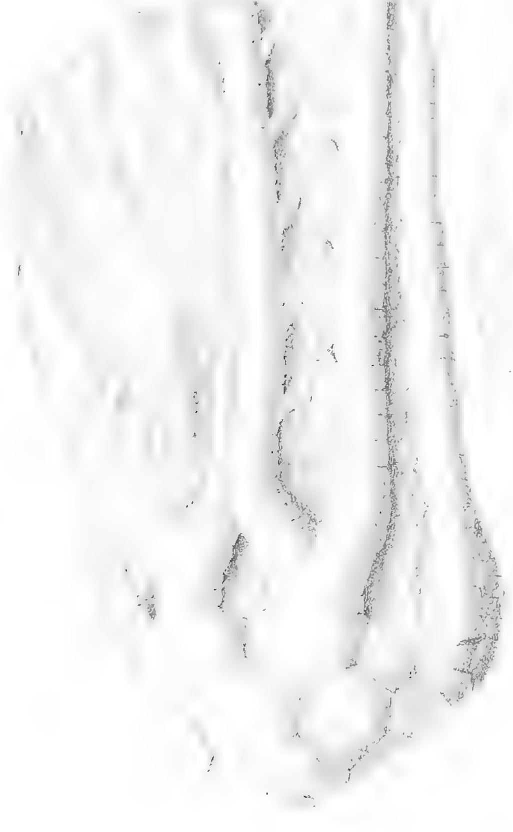

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PLATE XIV.

PAGE.

Fig. 1. Dichocrinus expansus 500

1 *a*. An oblique posterior view of body and portions of the arms, as seen lying somewhat compressed in the matrix.

1 *b*. An under view of the body of a more suddenly expanded specimen (var. *Stelliformis*,) which may possibly belong to a distinct species.

1 *c*. A side view of the same.

Fig. 2. Forbesiocrinus Wortheni 496

A posterior view of body and arms nearly perfect, excepting that the surface is somewhat worn.

This is a typical *Forbesiocrinus* the anal, interradial and interaxillary spaces being all filled with plates.

Fig. 3. Zeacrinus concinnus 490

A side view of body, arms and piece of the column, all complete.

Fig. 4. Onychocrinus exculptus............ 498

An oblique posterior lateral view of a large nearly perfect specimen. Here it will be seen that the anal series of pieces rise like small simple arms from one of the subradials in direct succession while on the right of this there can be seen remains of an integument composed of numerous very minute irregular pieces. This doubtless filled the space on each side of the true anal series. The interradials are seen to curve inward above, and, according to Mr. Lyon, form a solid vault. It is also probable that the vault pieces continued on out, arching over and covering the free rays to the first bifurcation. These characters, and the very peculiar structure of the arms, will be seen to contrast strongly with those of true *Forbesiocrinus*, on comparison with fig. 2 of this plate.

Fig. 5. Dichocrinus ficus ... .502

5 *a*. A view of posterior side of the body and arm-bases.

5 *b*. Another view of same.

Fig. 6. Scaphiocrinus depressus?. 492

A side view of the body, arms, and some of the pinnulæ, the body being flattened by pressure.

Fig. 7. Scaphiocrinus (sp. undet.) ....

Side view of body and arms.

Fig. 8. Scaphiocrinus depressus................................... 492

A side view of body, with some of the arms and pinnulæ attached.

Fig. 9. Calceocrinus Bradleyi.. 502

A dorsal or anterior view of body, and a portion of the arms, with a part of the column.

Fig. 10. Catillocrinus Bradleyi.... 501

10 *a*. A side view of body and a portion of the minute arm-bases, with a part of the column the latter appearing wider than natural, on account of accidental compression.

Fig. 11. Pentremites Wortheni? 506

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS

CRINOIDEA

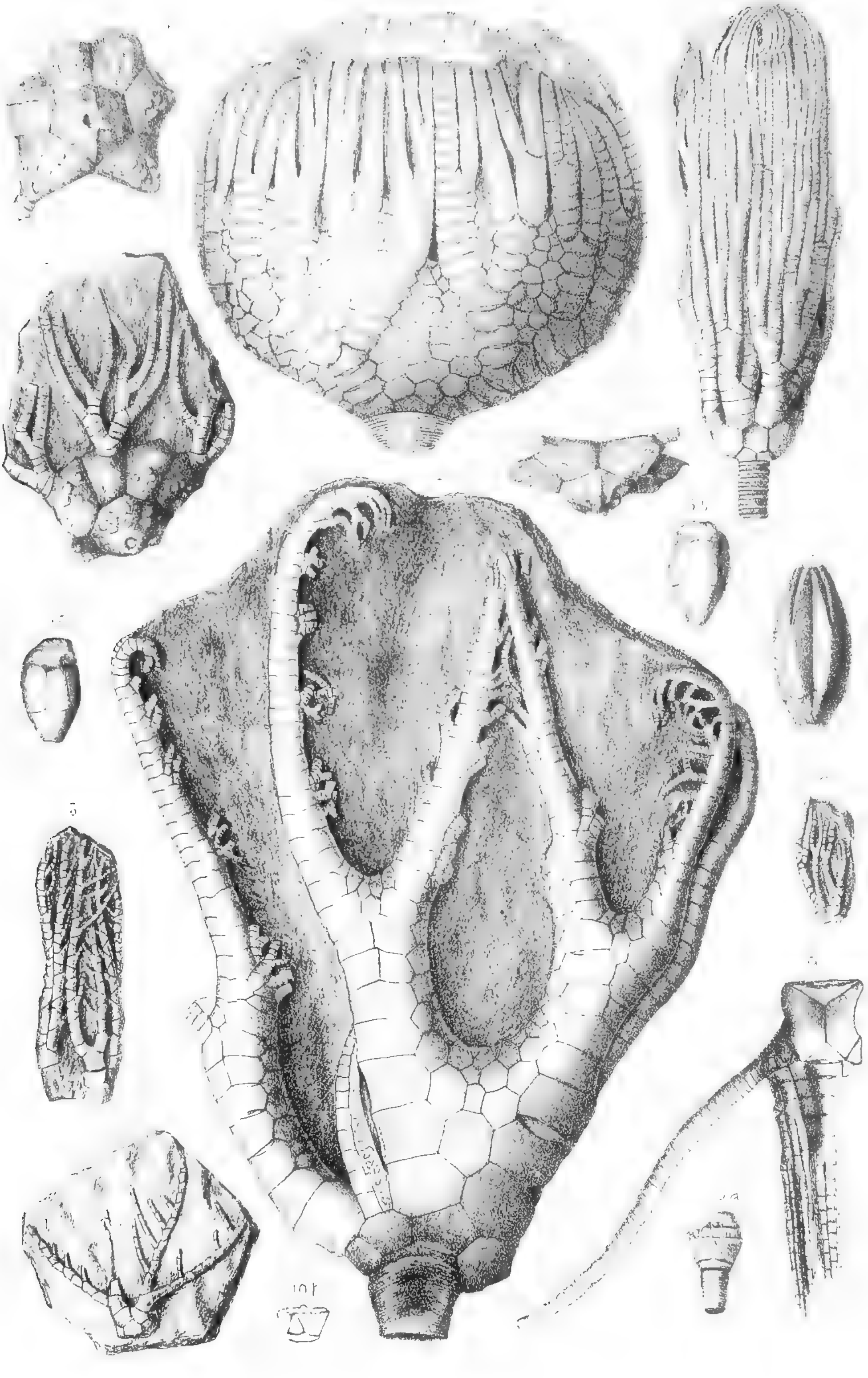

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PLATE XV

PAGE

Fig. 1. SCAPHIOCRINUS COREYI 494
An oblique posterior view of body and arms.

Fig. 2. SCAPHIOCRINUS MCADAMSI 495
A side view of body and arms.

Fig. 3. BARYCRINUS PENTAGONUS 487
3 *a*. Under side of body
3 *b*. Posterior view of same

Fig. 4. BARYCRINUS MAMMATUS 486
4 *a*. Under side view of body
4 *b*. Posterior view of same.

Fig. 5. SCAPHIOCRINUS UNICUS 493
A view of posterior side of body and arms.

Fig. 6. SCAPHIOCRINUS ÆQUALIS? 494
A side view of body and arms.

Fig. 7. FORBESIOCRINUS WORTHENI 496
Side view of body and arms complete, excepting that the surface is worn.

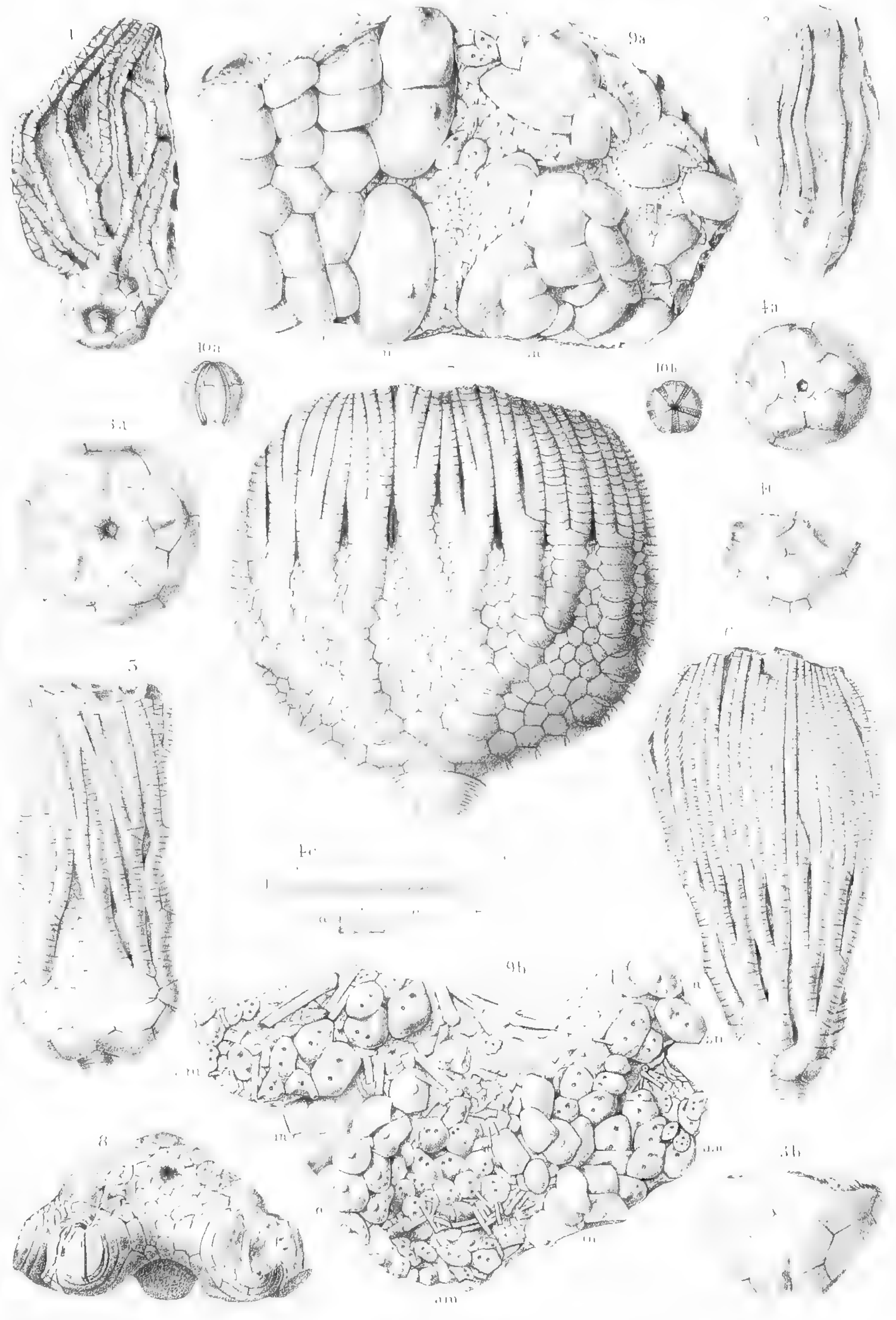
Fig. 8. AGARICOCRINUS WHITFIELDI 499
A posterior view, showing anal opening, arm bases, etc.

Fig. 9. PHOLIDOCIDARIS IRREGULARIS 512
9 *a*. A flattened fragment, apparently of the upper side of the fossil, (though it may be of the lower,) showing a number of the interambulacral plates mostly displaced but those on the left half nearly in their relative natural positions. All are seen to be destitute of primary tubercles, excepting the large elliptical plates that formed the margin of the ambulacral area. Near these are also seen a few of the small ambulacral pieces, showing three pores.
9 *b*. A fragment of the opposite side of the same fossil, consisting of ambulacral (*am*, *am*, *am*, *am*,) and interambulacral (*in*, *in*, *in*, *in*,) plates, with pieces of spines all rather confusedly mingled together. Nearly all the interambulacral plates, (excepting those at *in* x, which only show their inner surfaces,) are seen to be here provided with primary tubercles, while here the ambulacral pieces are often as large as those of the interambulacral series.
4 *c*. A part of one of the primary spines magnified about two diameters; *d* represents a portion of the surface magnified more highly, to show the very fine longitudinal striæ; *e* shows a transverse section.

Fig. 10. GRANATOCRINUS GRANULOSUS 508
10 *a*. Side view.
10 *b*. End view of same specimen.

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS Keokuk Beds. CRINOIDEA & ECHINOIDEA.



Thos Sinclair & Son lith. Phila

PLATE XVI.

PAGE

Fig. 1. AGELACRINITES SQUAMOSUS 513

Fig. 2. LEPIDESTHES COREYI. (For description see Vol. III, p. 525.) ....

2 *a*. About two-thirds of a specimen as seen somewhat flattened by pressure, the oral apertures not being seen at the base, in consequence of the rather oblique compression of the specimen placing it a little beyond the lower margin on the other side..

2 *b*. One of the interambulacral plates enlarged to show the surface granules.

Fig. 3. ONYCHASTER FLEXILIS 510

3 *a*. A specimen with the arms folded together and the outer integument of the disc and the dorsal side of the inner ends of some of the arms removed so as to expose the upper side of the parts surrounding the mouth, and the upper edges of some of the arm pieces.

3 *b*. Upper or inner view of the parts surrounding the mouth, enlarged about two diameters.

3 *c*. Outer surface of one of the fine massive double pieces, represented by fig. 36, to which the arms articulate enlarged two diameters.

3 *d*. Articulating surface of one of the arm-pieces; about two diameters

3 *e*. The upper edge of same more highly magnified, showing the central pore or pit, marginal furrows, and the articulating sockets and processes below and above, seen in profile.

3 f. Some of the scales and their little knobs forming the outer integument of the whole fossil considerably enlarged. The condition of the specimens is such that the exact outline and arrangement of these scales cannot be seen as distinctly as represented, but they appear to be arranged on the arms as shown in the figure.

3 *g*. One of these scales with the articulating knob removed and showing the central pit to which the knob was attached, enlarged

3 *h*. One of the articulating knobs much enlarged.

3 *i*. A small ossicle, (considerably enlarged,) believed to belong to the under side of the arms though not seen in place. Around its broader left margin are seen some five or six little pits, probably for the articulation of minute spines.

3 *j*. One of the spines seen along the under side of the arms enlarged to show its longitudinal striæ

3 *k*. An entire specimen, with its arms folded together, and covered by the outer integument, as seen from below. The specimen however, does not show any of the parts of the under side of the arms or body

5 *l*. A smaller specimen with the arms folded under, and showing the dorsal side of both body and arms covered by the outer integument.

Fig. 4. PENTREMITES (TROOSTOCRINUS) WOODMANI..................................506

4 *a*. A view of the under side, showing the three large excavations of the basal, and the lower part of three of the radial pieces also the central concavity for the attachment of the false basal, or subradial pieces, which have been broken away.

4 *b*. A side view of the same specimen, showing a part of one of the pseudo-ambulacral arms

4 *c*. Another side view of the same specimen.

4 *d*. An enlargement of a portion of the surface of one of the radial pieces, to show the very minute longitudinal striæ, as seen under a strong magnifier.

Fig. 5. PROTASTER ? GREGARIUS...509

5 *a*. A cast of the dorsal side of the disc, and impressions of the under side of portions of the arms, all magnified two diameters.

5 *b*. Impression of the under side of the disc and of the inner ends of the arms, and parts around the mouth; enlarged two diameters.

5 *c*. An impression of the under side of a portion of one of the arms, still further enlarged

5 *d*. The same of the upper of do.

5 *e*. An impression of one side of a part of one of the arms enlarged.

Fig. 6. PLATYCRINITES HEMISPHERICUS 506

6 *a*. A view of the under side of the body and arms, with (P,) the shell of a *Platyceras infundibulum* attached to one side so as to cover the anal opening. The margins of the lip of the *Platyceras* are seen to conform exactly to the inequalities of the surface of the crinoid even to the formation of large sinuses on each for the reception of its arm-bases. These arms were accidentally broken away in cleaning the specimen, but their stumps are seen protruding from the sinuses on each side of the shell at *ab*, *ab*. The ends of the divisions of the arms broken away are seen in the matrix, at *ar*, *ar*, on each side.

6 *b*. A side view of the same specimen, showing the stump of one of the arms protruding at *ab*, from the profound sinus in the lip of the *Platyceras*.

6 *c*. A side view of another specimen of the same crinoid, with the same *Platyceras* (P) attached to its side with the arms of the crinoid occupying a deep sinus at s in the lip of the shell.

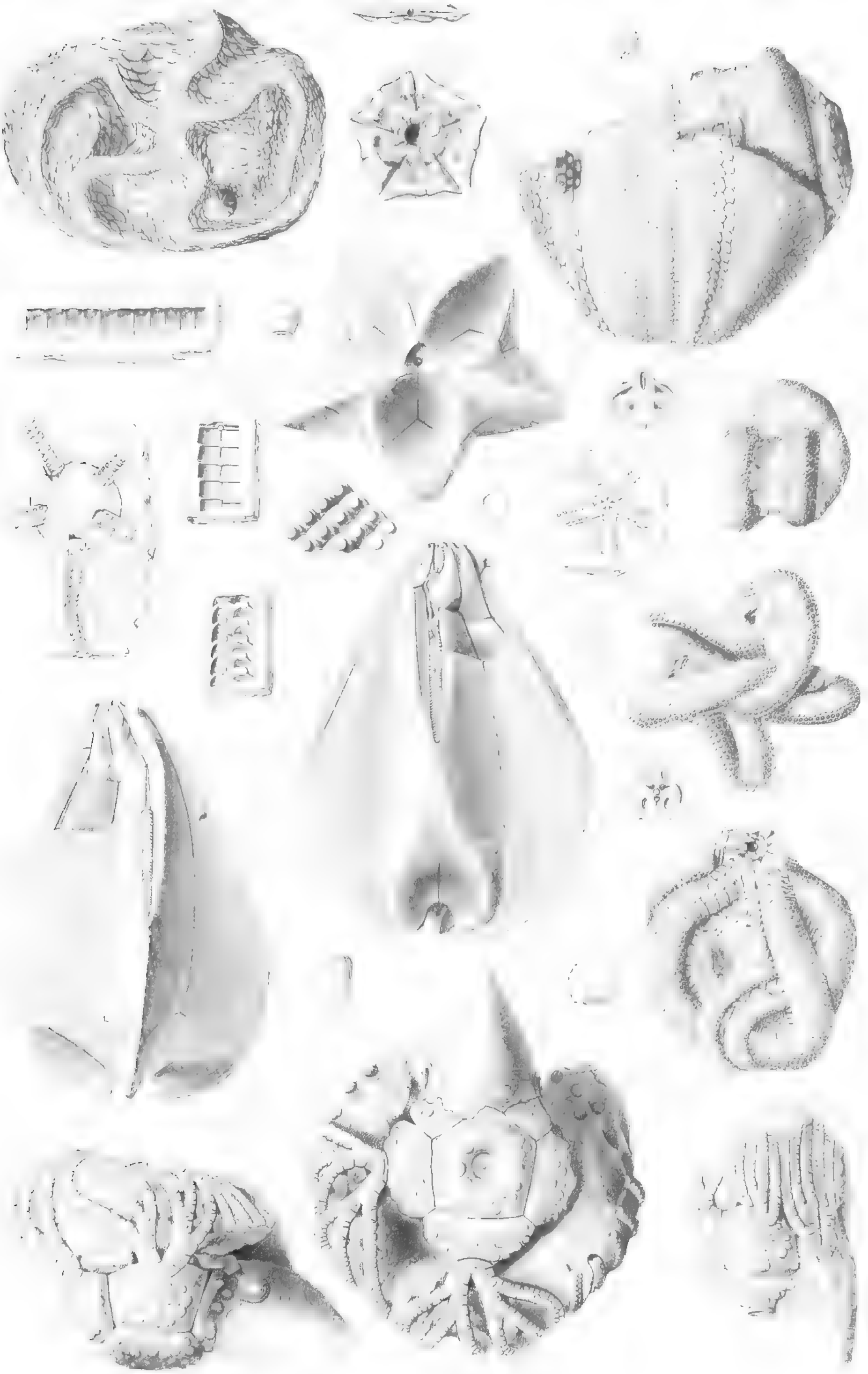


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PLATE XVII.

PAGE.

Fig. 1. PLATYCERAS UNCUM 516

1 *a.* An anterior view, showing a strong anterior ridge and marginal sinus.

1 *b.* A lateral view.

Fig. 2. PLATYCERAS EQUILATERA 518

2 *a.* An anterior view; showing a deep sinus on each anterior lateral margin, and a linguiform projection of the front margin between. It is probable that this specimen grew on the side of a Crinoid, and that these sinuses were formed to receive the arms of the Crinoid on each side.

2 *b.* A view of the aperture and apex of the same specimen.

2 *c.* A side view of the same.

2 *d.* A side view of another specimen, differing considerably in form, and possibly belonging to a different species. The difference, however, may have been produced by the animal having attached itself to a differently formed surface during the growth of the shell. The shell is also distorted a little by accidental depression.

2 *e.* A view of the dorsal side of the last.

2 *f.* Aperture and apex of the same.

Fig. 3. PLATYCERAS INFUNDIBULUM 517

3 *a.* A side view.

3 *b.* An anterior view of a larger specimen, with the immediate apex broken away.

3 *c.* A side view of the last.

3 *d.* An internal cast, with remaining portions of the shell of a more attenuated form, possibly of another species.

3 *e.* A posterior view of a similar internal cast to that represented by fig. 3 *d.* It shows the horse-shoe-shaped muscular scar very distinctly at *s s.*

3 *f.* A side view of same.

Fig. 4. PLATYCERAS FISSURELLA 519

4 *a.* A dorsal view of the typical specimen; showing an opening just in advance of the apex, that was supposed to be a natural perforation, by Prof. Hall, at the time he named the species. To us, however, it seems to be an accidental break in the shell.

4 *b.* A side view of the same.

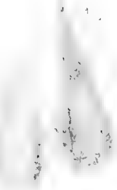
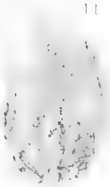
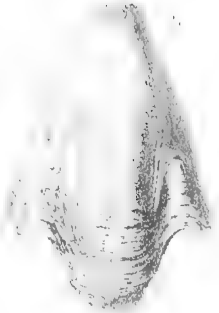
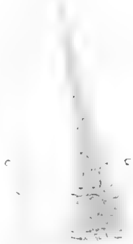
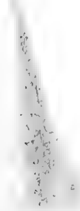
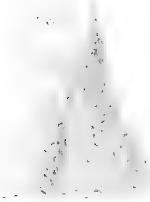
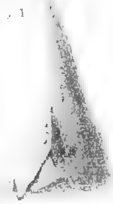
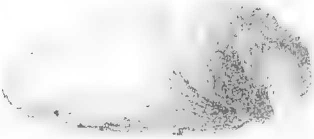
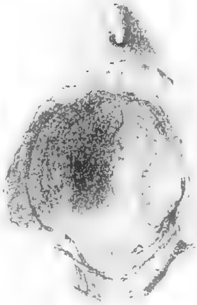
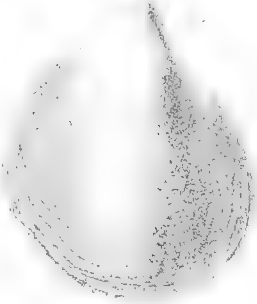
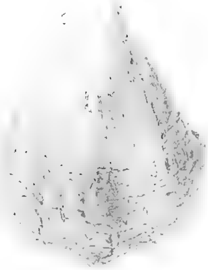
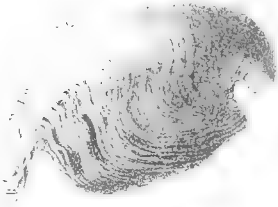
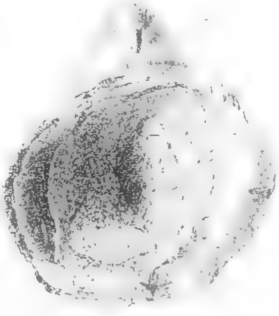
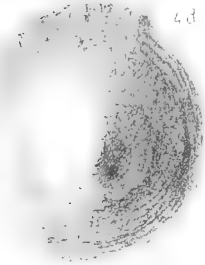
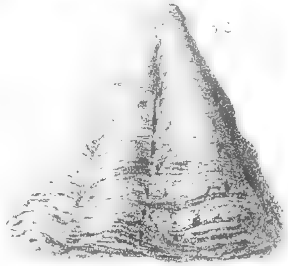
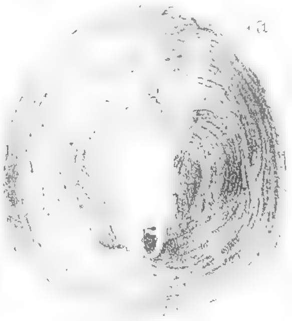
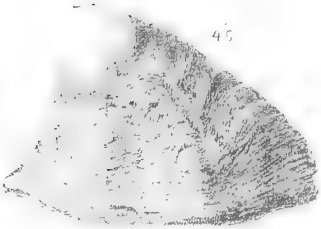
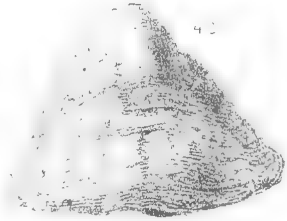
4 *c.* An anterior view of same.

4 *d.* A dorsal view of a smaller specimen of the same species.

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS

GASTEROPODA

Chas K Worthen, del

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PLATE XVIII.

PAGE.

Fig. 1. NAUTILUS (DISCITES) DISCIFORMIS 522

1 *a*. Side view of a nearly perfect specimen; one-half natural size.

1 *b*. View of the inner side of septa,

1 *c*. Transverse section, showing position of siphuncle.

Fig. 2. NAUTILUS (SOLENOCHILUS) LEIDYI 524

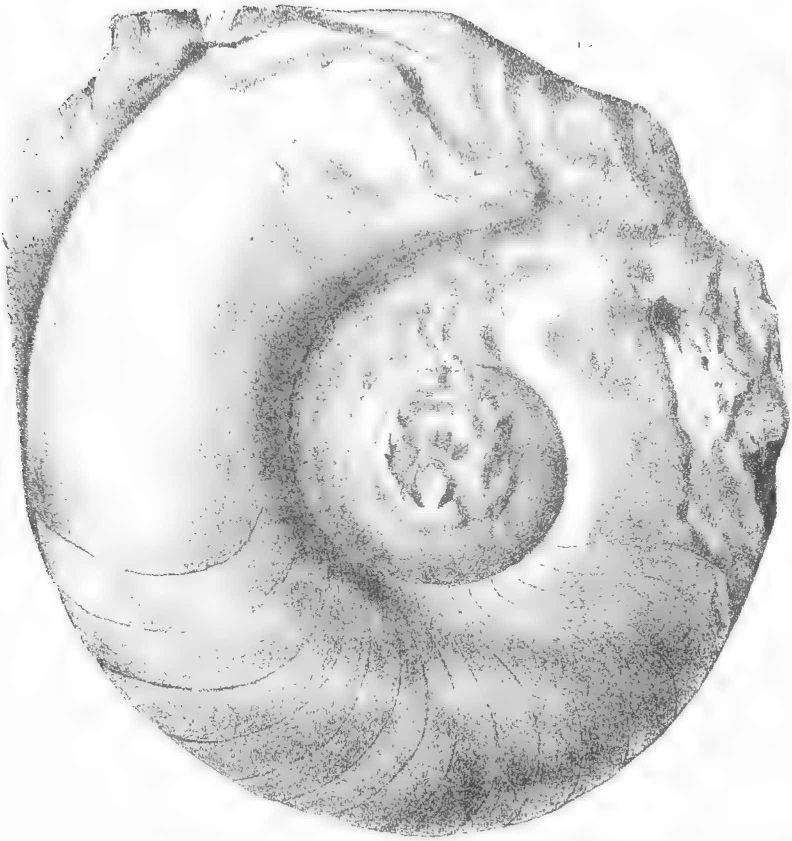
2 *a*. Side view of outer chamber.

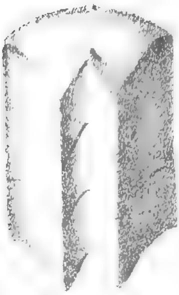
2 *b*. Dorsal view of the same.

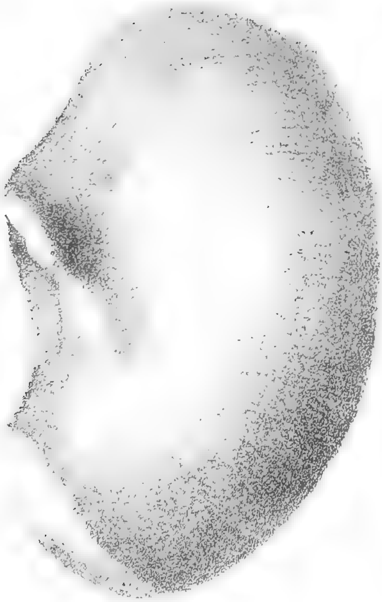
GEOLOGICAL SURVEY OF ILLINOIS

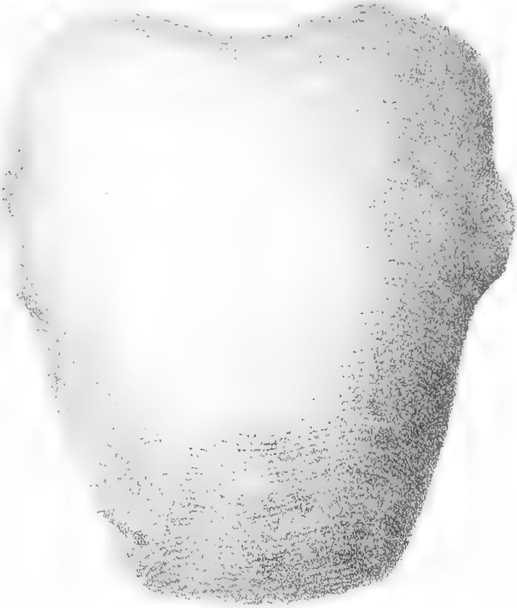
CARBONIFEROUS

CEPHALOPODA









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GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS

MISCELLANEOUS.

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A H Worthen dirext

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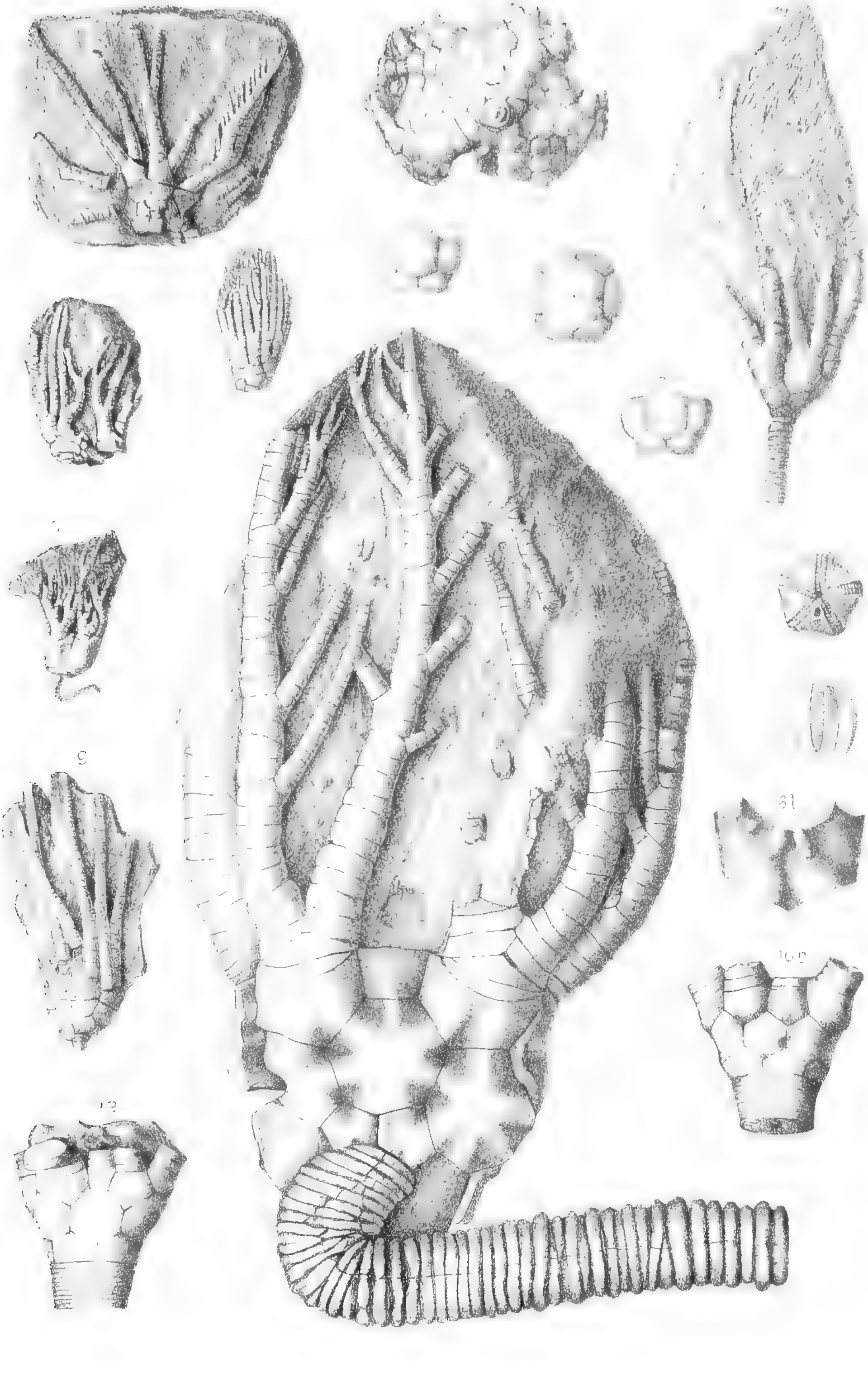
GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS

CRINOIDEA



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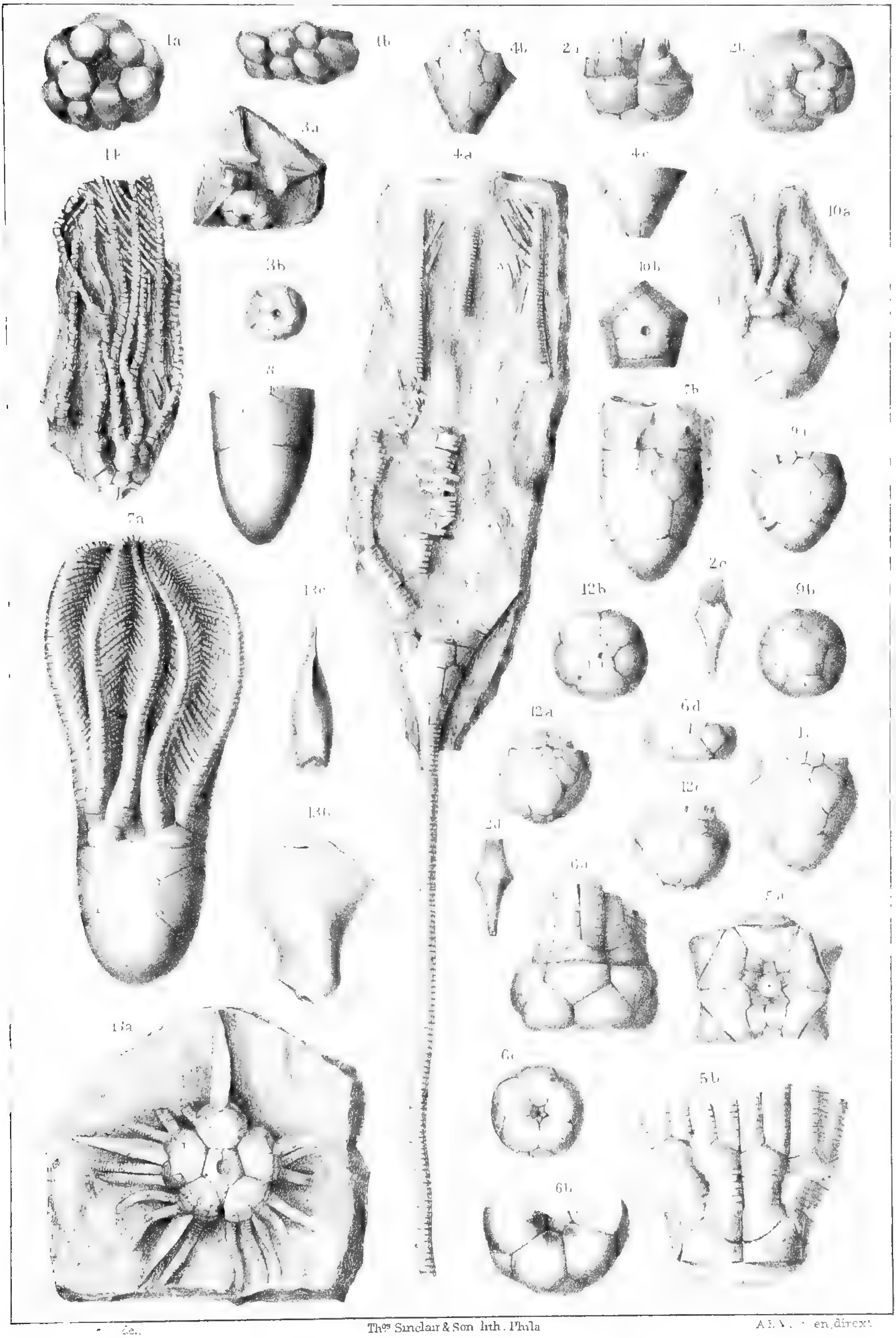
GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS. Chester Beds CRINOIDEA.



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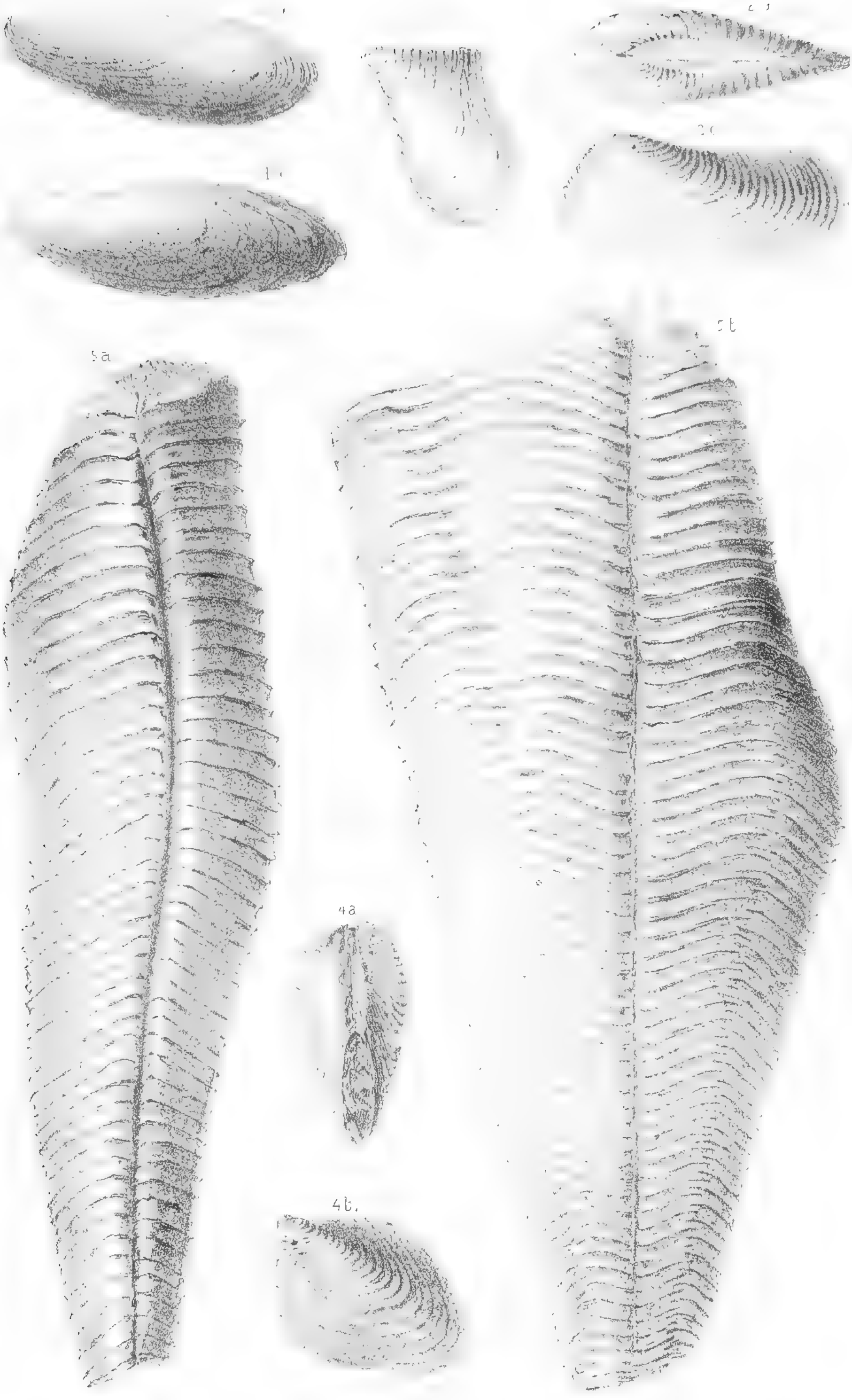
CARBONIFEROUS beds MOLLUSCA



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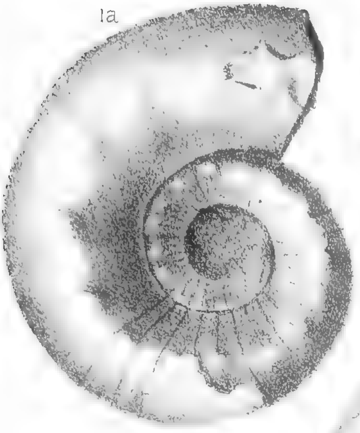
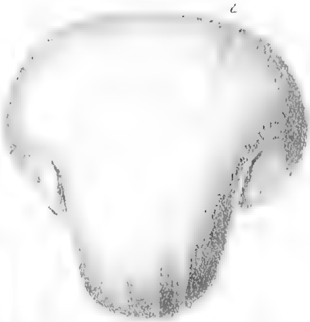
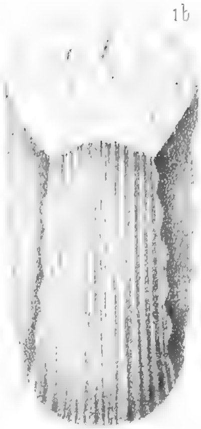
GEOLOGICAL SURVEY OF ILLINOIS

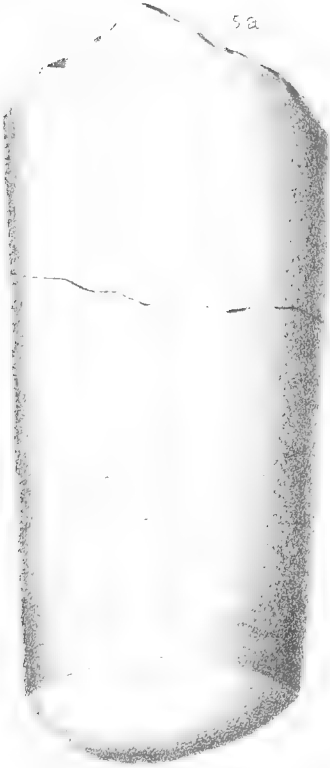
CARBONIFEROUS

CEPHALOPODA









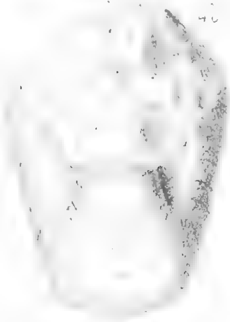


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PLATE XXIV.

PAGE.

Fig. 1. Lophophyllum proliferum 560

1 *a*. A side view of a specimen, with the walls of the calice broken away so as to show the columella, with its striated sides.

1 *b*. An unusually long specimen, broken off just below the bottom of the calice, and a part of one side, for some distance further down, broken away, so as to show the columella continued on down the middle, and the distant, arching dissepiments on each side.

1 *c*. A fragment from near the lower extremity of another specimen (enlarged), split longitudinally so as to expose one side of two of the septa, with their striated surfaces.

1 *d*. A transverse section (enlarged about three diameters) near the base of the calice, showing the columella in the middle, and the septa radiating to the outer wall all around, with a very short intermediate one between each two of the others. The small *fossa* is seen above formed by the presence of three short septa together.

Fig. 2. Scaphiocrinus carbonarius 562

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2 *b*. A side view of a specimen with some of the second radial and first arm pieces attached. The anal piece is also seen at *a*, raised out of its natural position.

2 *c*. A view of the under side of the same specimen, represented by fig. 2 *a*.

Fig. 3. Poteriocrinites Macoupinensis 561

3 *a*. An anterior view of the body.

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Fig. 4. Agassizocrinus carbonarius 566

A side view of the anchylosed base.

Fig. 5. Scaphiocrinus ? hemisphæricus 561

5 *a*. A posterior side view of body.

5 *b*. A view of the under side of the same.

Fig. 6. Erisocrinus typus 561

6 *a*. View of the under side of the body.

6 *b*. A view of the upper side of a slightly larger specimen; showing the articulating surfaces of the first radial pieces for the attachment of the second radials: also the internal cavity of the body, partly filled with the matrix.

6 *c*. Anterior side of same.

6 *d*. Side view of a specimen consisting of the first and second radials only, the latter being a little displaced.

6 *e* Upper edge of a large first radial piece, showing the articulating surface for the reception of the second radial.

6 *f*. An inside view of the same.

6 *g*. An outside view of a large second radial.

6 *h*. A view of the inner side of the last, showing also an oblique view of the upper surface on which two of the arms articulated.

Fig. 7. Fusulina gracilis 560

Fig. 8. Fusulina ventricosa 560

8 *a*. Side view, magnified about two diameters.

8 *b*. An opposite view of the same.

Fig. 9. Eupachycrinus tuberculatus 566

9 *a*. Posterior view of the body.

9 *b*. A view of the under side of the same.

PLATE XXIV—*Continued.*

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Fig. 10. EUPACHYCRINUS FAYETTENSIS 565

10 *a*. An oblique view of a specimen partly imbedded in matrix: showing body and parts of arms.

10 *b*. An under view of same.

Fig. 11. ZEACRINUS ACANTHOPHORUS 563

11 *a*. A side view of body and parts of some of the arms, with the upper part of the ventral extension, showing its expanded and depressed-convex top, with the marginal row of spines mainly broken away.

11 *b*. An upper view of the nearly flat top of the ventral extension, with its radiating row of marginal spines restored in outline.

11 *c*. A view of the under side of the same specimen.

11 *d*. The under side of one of the ventral spines of, probably, another species of this type. The furrows *(f)* at the larger end are formed by pores passing through the sutures between this piece and the next range below; there being numerous pores passing through the sutures of the plates forming the sides of the ventral portion of all of this type of Crinoids.

11 *e*. The upper dorsal side of the same specimen. [These spines have a wide geographical range in the Coal Measures of the West and are often mistaken for the spiniferous second radials of *Zeacrinus mucrospinus*, with which they are frequently found associated.]

11 *f*. A curious piece developed into a short, compressed spine. It evidently belongs to the side of the ventral part of a Crinoid allied to that represented by fig. 11 *a*, and the furrows on its sides show that it had pores passing through sutures between it and the other plates with which it connected.

11 *g*. An edge view of the same piece.

11 *h*. An end or inner view of the same, showing that one of the pores passed through between each side and that of each contiguous piece.

Fig. 12. ZEACRINUS MUCROSPINUS 563

12 *a*. One of the spiniferous second radial pieces figured for comparison with fig. 11 *a*, *b*. It represents the upper side on which the arms rested, the linear marginal pits being for the elastic ligament connecting the arms to this piece.

12 *b*. The under side of the same.

Fig. 13. ARCHÆOCIDARIS? *(sp. undet.)*..

13 *a*. One of the primary spines, natural size.

13 *b*. A side view of same, showing its curve.

13 *c*. A straight spine, with the articulating end broken away; probably of the same species.

13 *d*. A more clavate spine, broken in the same way; probably from a different part of the same species.

13 *e*. A subglobose form, with the shank or articulating end broken away; possibly belonging to the same species.

Fig. 14. SEPTOPORA CESTRIENSIS, of Prout, from the Chester Limestone; figured for comparison with fig. 15, from the Coal Measures.

14 *a*. A portion of the fossil, natural size, non-poriferous side.

14 *b*. A part of the same, enlarged to show the minute surface striæ and scattering, pore-like pits.

14 *c*. A part of the poriferous side of same, more highly magnified to show the animal cells, and the mesial longitudinal carinæ, with their spine-like tubercles.

Fig. 15. SYNOCLADIA VIRGULACEA, var. BISERIALIS, of Swallow, Geinitz, and others.

15 *a*. A portion of the fossil showing its non-poriferous side, natural size.

15 *b*. A part of the same, enlarged to show the fine surface striæ and scattering pits.

15 *c*. The poriferous side, more highly magnified to show the animal cells and mesial carinæ, with their spine-like tubercles. The few minute supplementary or dwarfed cells, *sp*, *sp*, are not peculiar to the specimens from the Coal Measures, but are also seen on some of those from the Chester beds.

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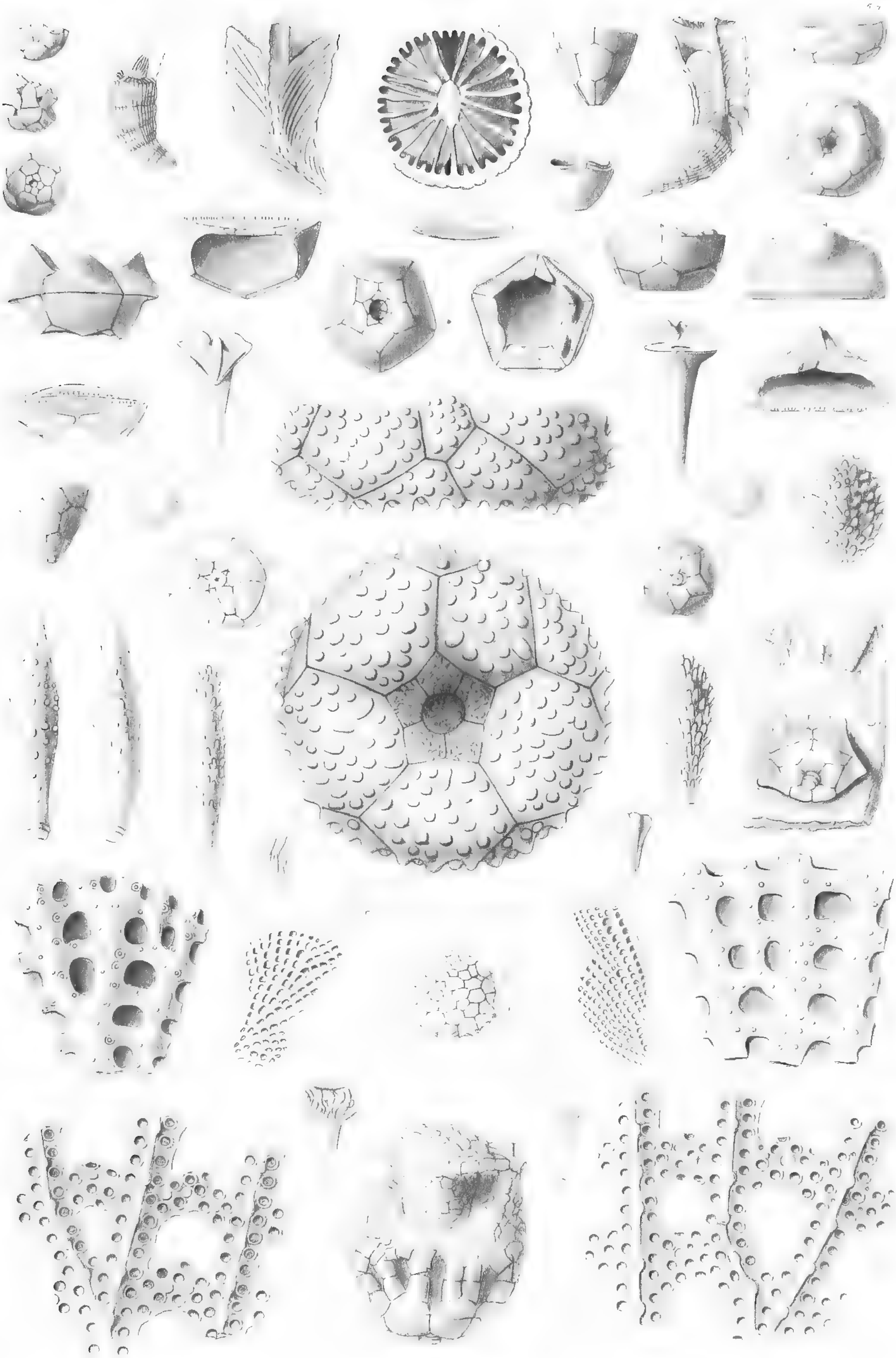
CARBONIFEROUS Measures MISCELLANEOUS



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GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS. Coal Measures BRACHIOPODA.

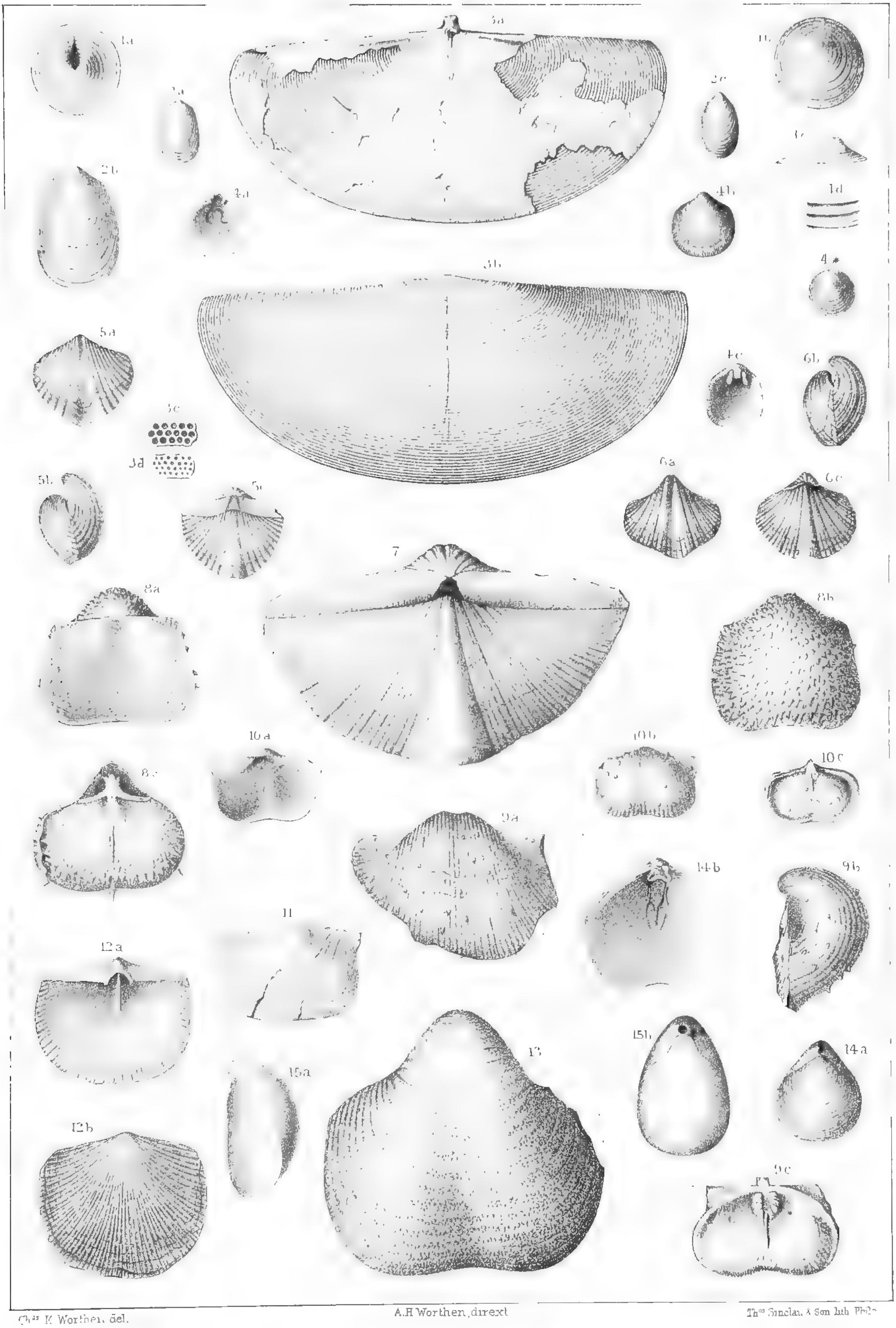

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PLATE XXVI.

PAGE.

Fig. 1. Avicula longa 578
1 *a*. Side view of left valve, with a portion of posterior wing and posterior extremity broken away.
1 *b*. The same as enlarged and seen from above, to show that the cardinal area (*ar*) has but a single cartilage pit (*c*.) It also shows the long linear posterior hinge tooth (st,) and prominent subconic anterior tooth (*a*.) with the smaller, less prominent one, just behind it.

Fig. 2. Lima retifera 588
A side view of an internal cast of the left valve, showing only the radiating costæ.

Fig. 3. Macrodon delicatus 575
A view of the outside of the left valve, magnified a little more than two diameters.

Fig. 4. Macrodon tenuistriatus 576
4 *a*. View of left valve, magnified to about three diameters.
4 *b*. Dorsal view of same specimen, showing the convexity of the two valves, the cardinal area, etc.

Fig. 5. Monotis? gregaria 573
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5 *b*. The two valves of another specimen, as seen opened and flattened out on the surface of the shaly matrix, the hinge margins being joined together; the whole magnified between two and three diameters.

Fig. 6. Pleurophorus oblongus? 589
6 *a*. An internal cast, right hand view.

Fig. 6 *b*. Pleurophorus? (sp. undet) ....
A view of left valve.

Fig. 7. Aviculopecten neglectus 589
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7 *b*. Internal and hinge view of a smaller specimen of same valve, magnified about two diameters.
7 *c*. The hinge of the same more highly magnified, to show the oblique central cartilage pit and the smaller pits on each side extending along the whole length.
7 *d*. Surface of same valve magnified, to show the very fine obscure concentric striæ, crossed by still more minute radiating lines on the body part of the valve.

Fig. 8. Nucula parva 589
8 *a*. Left valve magnified two diameters.
8 *b*. Inside and hinge view of the same valve of a smaller specimen, magnified about three and a half diameters, to show the hinge teeth, and minute cartilage pit under the beaks.

Fig. 9. Nucula Beyrichi? 589
9 *a*. Left view of a gibbous specimen, with elevated beak, magnified nearly two diameters.
9 *b*. Same view of a smaller specimen with lower beak and more compressed valves; magnified three diameters.
9 *c*. Dorsal view of same.

Fig. 10. Nuculana (sp. undet) ....
Magnified nearly three diameters.

Fig. 11. Myalina perattenuata 582
View of outside left valve, natural size.

PLATE XXVI—*Continued.*

PAGE.

Fig. 12. Entolium aviculatum..588
12 *a.* An internal cast of one of the valves. [The prominence of the alate lateral margins above the middle, not constant in all of the specimens.]
12 *b.* Internal cast of apparently the opposite valve of the same species, the auricles being apparently always elevated in one valve, and straight above in the others.
12 *c.* The interior of a specimen like 12 *a*, magnified to show the small central cartilage pit, and the widely diverging teeth. It also shows clearly that there are no minute cartilage pits along the hinge margin on either side of the central one, as in the otherwise very similar type of the genus *Pernopecten.*

Fig. 13. Edmondia ovata..
A left side view of an internal cast

Fig. 14. Avicula Morganensis..576
14 *a.* A left valve, with the anterior auricle broken away.
14 *b.* A smaller do., with both auricles or wings nearly entire.

Fig. 15. Allorisma costata..585
A view of cast of right valve retaining some portions of the very thin shell

Fig. 16. Schizodus curtus..582
16 *a.* View of right valve, natural zize.
16 *b.* Same view of same enlarged to about two and a half diameters.
16 *c.* A dorsal view of same.

Fig. 17. Schizodus Rossicus, de Vern?..
17 *a.* A small imperfect specimen, magnified about three diameters, being a view of the outside of right valve.
17 *b.* Dorsal view of same species, showing the valves more compressed than fig. 16 *c.*
17 *c.* Hinge of left valve magnified *l* being the little marginal furrows for the ligament; *bt* the largest slightly emarginate tooth, and *(at)* the smaller anterior tooth. Under the ligament furrow *(l)* there is sometimes traces of a very faint projection, marked *pt*, but it seems doubtful whether or not this ought to be counted as a third tooth.
17 *d.* Hinge of right valve magnified. The large prominent tooth *(bt)* fits into the pit *(p)* between the two well defined teeth of the other valve, while the smaller one *(pt)* occupies the pit just behind the large tooth of the left valve.
17 *e.* The extremely minute surface sculpturing of the same species strongly magnified. The same minute sculpturing is also seen on the specimens represented by fig 18 and 19.

Fig. 18. Schizodus Rossicus, de Vern?..
A view of a considerably larger left valve, differing slightly in form from the last but probably belonging to the same species.

Fig. 19. Schizodus perelegans..581
19 *a.* A left side view of an imperfect specimen. Its posterior margin is seen on the other side to extend back as far as represented by the outline.
19 *b.* An anterior view of the same specimen showing the distinct convexity of the valves, and the very regular concentric lines ending abruptly before quite reaching the most convex part of the valves. [Some portion of the anterior margins of the valves below the middle are restored in this figure.]

Fig. 20. Syntrielasma hemiplicata..571
20 *a.* Posterior view, showing the very small cardinal area and open foramen.
20 *b.* Anterior view of another specimen, showing the strongly plicated margins of the valves.
20 *c.* A dorsal view of a larger specimen, with the shell about the umbo removed so as to show the socket plates in the internal cast.
20 *d.* Ventral view of same, with a part of the shell removed in the same way so as to show the three very closely approximated laminæ, as seen in the cast.
20 *e.* Surface striæ nearly natural size.
20 *f.* The same magnified so as to show minute openings in the same, as we often see in *Orthis.*

Fig. 21. Meekella striato-costata..571
21 *a.* A side view of a specimen scarcely of the medium size of the species.
21 *b.* Posterior view of the same, showing the very high area and narrow closed fissure, short hinge line, etc.
21 *c.* An internal cast of the ventral valve of a large individual, showing the cavities occupied by the strong, nearly parallel dental laminæ.
21 *d.* Two of the plications of this species enlarged so as to show how the striæ on the same converge as they approach the anterior margin in large individuals.

Fig. 22. Rhynchonella Osagensis..571
22 *a.* A ventral view of an imperfect specimen with three plications in the sinus.
22 *b.* The same view of another specimen with only two (the usual number) plications in the sinus.

Fig. 23 Allorisma Geinitzii..586
A right side view of an internal cast, natural size.

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS.

Coal Measures

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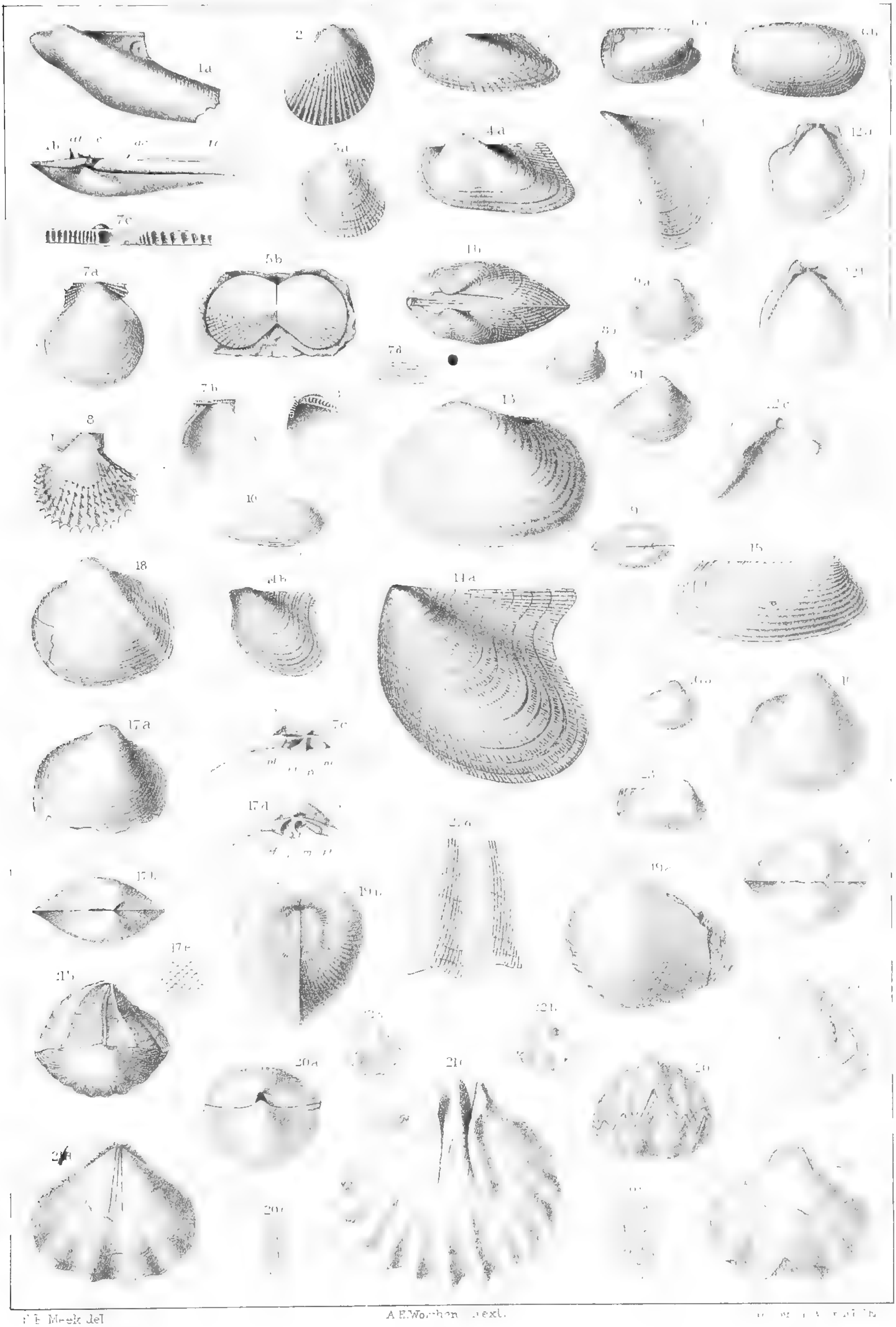

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PLATE XXVII.

PAGE

Fig. 1. Solenomya (sp. undet.) ....

1 *a.* View of outside of right valve, with margins slightly restored in places.

1 *b.* Dorsal view of the two valves, as seen somewhat displaced, and one of them somewhat broken behind the beak.

Fig. 2. Placunopsis carbonaria 578

2 *a.* Upper or right valve broken in places, but showing the peculiar transverse costæ crossing the umbo often seen on this species; as well as the radiating costæ, concentric markings etc.

2 *b.* A smaller specimen of same valve.

2 *c.* Another large specimen apparently of the same species, but with a much less prominent umbo, and a straighter cardinal margin.

2 *d.* An internal cast of a small specimen

Fig. 3. Chænomya Minnehaha? 588

3 *a.* View of right valve.

3 *b.* Dorsal view of the two valves showing the wide posterior gape, and convexity of the valves.

3 *c.* Enlargement of radiating rows of minute surface granules

Fig. 4. Edmondia peroblonga. 583

Left side view of internal cast.

Fig. 5. Chænocardia ovata. 586

5 *a.* View of left valve.

5 *b.* An anterior view of same showing the anterior gape

Fig. 6. Schizodus amplus 579

6 *a* A dorsal view of internal cast showing the convexity of the valves, muscular impressions, posterior umbonal sutures, etc

6 *b.* A side view of same

Fig. 7. Clinopistha radiata, var. lævis 584

7 *a.* A view of left valve of one of the larger specimens.

7 *b.* A dorsal view of same showing the short ligament to be on the shorter side of the beaks, and the valves to be closed at both ends.

7 *c* A posterior view of same.

7 *d.* A right side view of a small specimen, almost without traces of radiating striæ.

7 *e.* A ventral view of same, showing the valves to be closed below.

7 *f.* An internal cast showing muscular impressions.

Fig. 8. Cardiomorpha Missouriensis 585

8 *a.* Dorsal view.

8 *b.* View of left valve.

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS LAMELLIBRANCHIATA

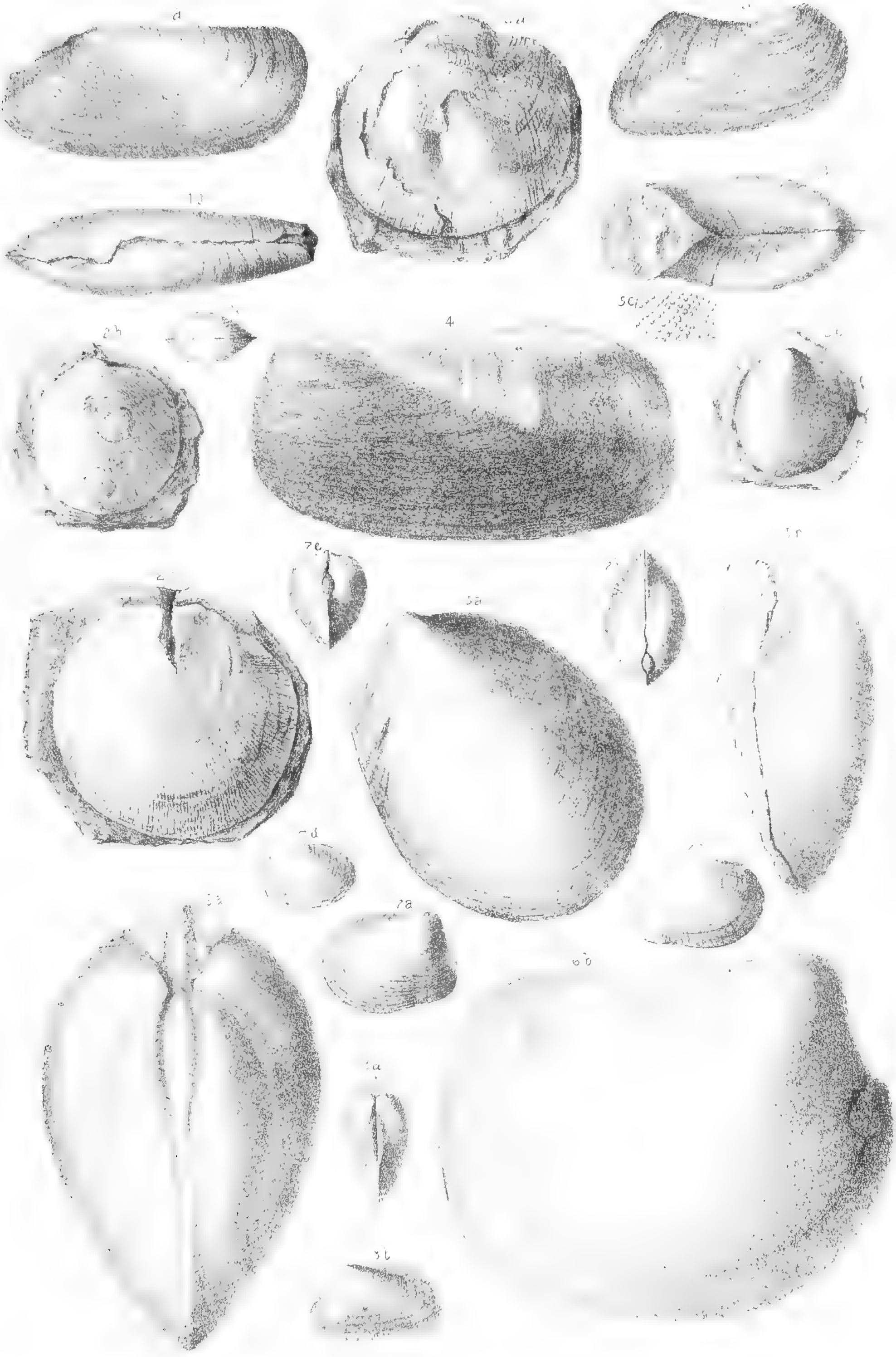

PLATE XXVIII.

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Fig. 1. PLEUROTOMARIA CONOIDES 603
1 *a.* Side view, natural size.
1 *b.* View of opposite side and aperture.
1 *c.* Enlarged view of same species, to show surface markings and spiral band.

Fig. 2. MICRODOMA CONICA 598
2 *a.* Side view, enlarged a little more than three diameters.
2 *b.* An opposite view of same, showing the aperture.

Fig. 3. NATICOPSIS WHEELERI 595
3 *a.* Dorsal side view, natural size.
3 *b.* Opposite side of same, showing aperture and columella.

Fig. 4. PLATYCERAS SPINIGERUM 594
4 *a.* Side view, showing the spine bases.
4 *b.* View of opposite side.
4 *c.* Profile view, showing the aperture.

Fig. 5. PLEUROTOMARIA SPIRONEMA 601
5 *a.* Dorsal view, natural size, showing the smooth, flat spiral band above the middle of the body volution.
5 *b.* View of opposite side, showing aperture and the sinus in the lip.

Fig. 6. MURCHISONIA INORNATA 599
6 *a.* Dorsal view, enlarged about three diameters.
6 *b.* Opposite side of same, showing aperture and sinus.

Fig. 7. POLYPHEMOPSIS CHRYSALIS 596
7 *a.* Dorsal view, natural size.
7 *b.* An opposite view of the same.

Fig. 8. MACROCHEILUS ALTONENSIS 593
8 *a.* Dorsal view of specimen with the outer lip broken away.
8 *b.* An opposite view of same, showing the thickened inner lip.

Fig. 9. NATICOPSIS SUBOVATUS 595
9 *a.* Ventral side view, showing the aperture and broad flattened inner lip.
9 *b.* An opposite view of same.

Fig. 10. A shelly operculum found associated with the species represented by fig. 9, and believed to belong to the same.
10 *a.* View of the inner side, showing the reniform scar of attachment.
10 *b.* View of the outer or under side of the same, showing by the striæ its submarginal nucleus, and concentric mode of growth.

Fig. 11. NATICOPSIS ALTONENSIS? 595
11 *a.* Side and aperture view, showing the thickened, transversely striated inner lip.
11 *b.* An opposite view of the same.

Fig. 12. NATICOPSIS ALTONENSIS? var. GIGANTEUS ....
12 *a.* An aperture view, showing the thickened inner lip, outline of mouth, etc.
12 *b.* Opposite view of same.

Fig. 13. NATICOPSIS VENTRICOSUS 592
13 *a.* Dorsal view, natural size.
13 *b.* Opposite view, showing aperture and thickened inner lip.

Fig. 14. MACROCHEILUS NEWBERRYI 594
14 *a.* Dorsal view of a specimen with the outer lip broken away.
14 *b.* An opposite view of same, showing the thickened inner lip and columella to be twisted into a kind of obscure fold below.

Fig. 15. PLEUROTOMARIA COXANA 600
15 *a.* Dorsal view of an internal cast, retaining traces of fine transverse striæ.
15 *b.* An opposite view of same.

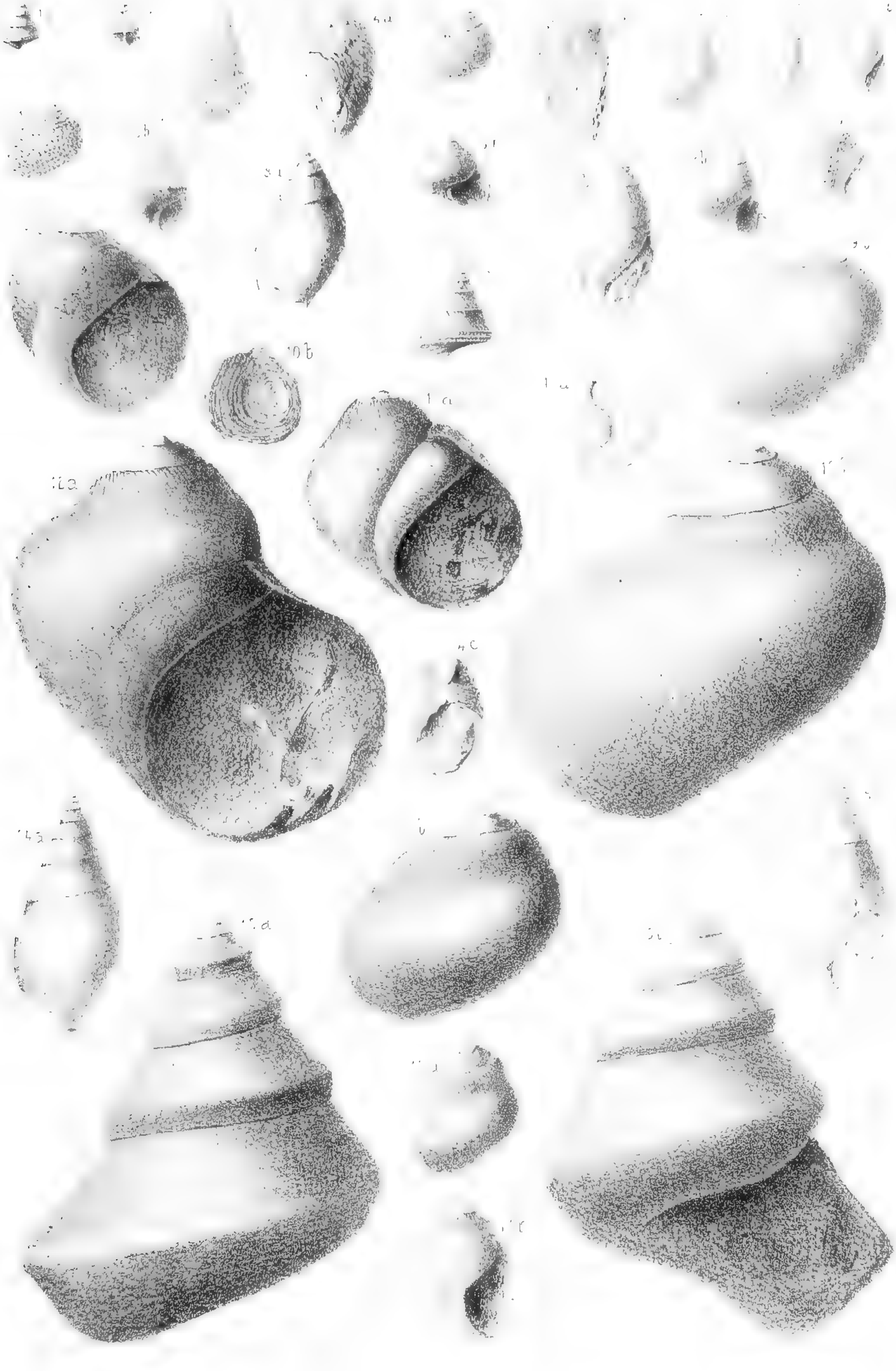

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PLATE XXIX.

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Fig. 1. Streptacis Whitfieldi. 596

1 *a.* View of spire and aperture, magnified about four diameters.

1 *b* Apex of spire, more highly magnified, and showing the first turn to be reversed, or raised edge upward.

Fig. 2. Loxonema semicostata. 596

2 *a* View of spire and aperture, magnified to about four diameters, to show the costate character of the upper turns.

2 *b* The apex of the spire, more highly magnified to show that the first turn is not reversed or raised upward.

Fig. 2½. Aclisina minuta. 594

2½ *a.* View of aperture and spire, enlarged about four diameters.

2½ *b.* Body volution and the next turn above greatly magnified to show the truncated, or slightly shouldered character of the upper edge of the whorls, and the backward curve of the minute lines of growth as they approach the upper margin of the whorls.

Fig. 3. Loxonema, (*sp. undet.*) ....

3 *a.* View of aperture and spire, magnified to between four and five diameters.

3 *b.* Apex of same, more highly magnified to show that it is not reversed

Fig. 4. Loxonema (Michelia ?) (*sp. undet.*) ....

4 *a.* View of aperture and spire, enlarged nearly five diameters.

4 *b.* Apex, more highly magnified to show that the first turn is not reversed and that the two next succeeding it are costated.

Fig. 5. Orthonema (Michelia ?) conica. 590

5 *a.* Side view, natural size.

5 *b.* An imperfect specimen, apparently of the same species, in which the lower edge of some of the lower turns projects a little just above the suture, and showing faint traces of two ridges above the angle of the lower volution.

5 *c* Another specimen, showing the former character more distinctly; also the form of the aperture. These may belong to another species.

Fig. 6. Aclis robusta 596

6 *a.* View of aperture and spire, enlarged to two and a half times the natural diameter.

6 *b.* The body volution, more highly magnified to show more clearly the revolving striæ, and the strongly sigmoid lines of growth.

Fig. 7. Dentalium annulostriatum 589

7 *a.* Enlarged two diameters; the specimen being imperfect at both ends.

7 *b.* A portion of same, more highly magnified to show more clearly the oblique, annular, raised lines.

Fig. 8. Dentalium Meekianum ?. 590

8 *a* A side view, magnified about two diameters.

8 *b.* A section of same, more highly magnified to show more distinctly the striæ.

8 *c* A portion of the surface, still more highly magnified to show minute granules, in addition to the striæ.

Fig. 9. Pleurotomaria ? valvatiformis 602

9 *a.* A view of aperture and spire, enlarged to about five and a half diameters.

9 *b.* Another view of same, as seen from above.

Fig. 10. Anomphalus rotulus 597

10 *a.* A side view, showing the aperture magnified about two and a half diameters.

10 *b.* View of under side of same.

10 *c.* View of upper side of same

PLATE XXIX—*Continued.*

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Fig. 11. EUOMPHALUS SUBRUGOSUS..607
11 *a.* An upper view of a rather small specimen, magnified to about twice its natural diameter, or to about the average size of adult specimens
11 *b.* A profile view of same.
11 *c.* A view of the under side of same.

Fig. 12. EUOMPHALUS SUBQUADRATUS..605
12 *a.* An upper side view; natural size.
12 *b.* Profile of same.
12 *c.* View of under side of same.
13 *a.* An upper view of another specimen, differing somewhat in form, but probably a variety of the same species as that represented by figure 12, with which it was found associated.
13 *b.* A profile view of the last.
13 *c.* A view of under side of same.

Fig. 14. EUOMPHALUS PERNODOSUS..604
14 *a.* View of upper side, natural size.
14 *b.* Profile of same, the specimen being distorted near the aperture.
14 *c.* An under side view of same.

Fig. 15. CHITON CARBONARIUS..608
15 *a.* Anterior dorsal shield, as seen from above.
15 *b.* An outline side view of same.
15 *c.* One of the intermediate dorsal shields, with its anterior processes partly preserved seen from above.
15 *d.* An internal view of same.
15 *e.* An outline lateral view of same.
15 *f.* Posterior shield, with its processes partly preserved—seen from above.
15 *g.* An outline lateral view of same.
15 *h.* A portion of the surface granular sculpturing seen on all of the shields.

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS. Coal Measures GASTEROPODA

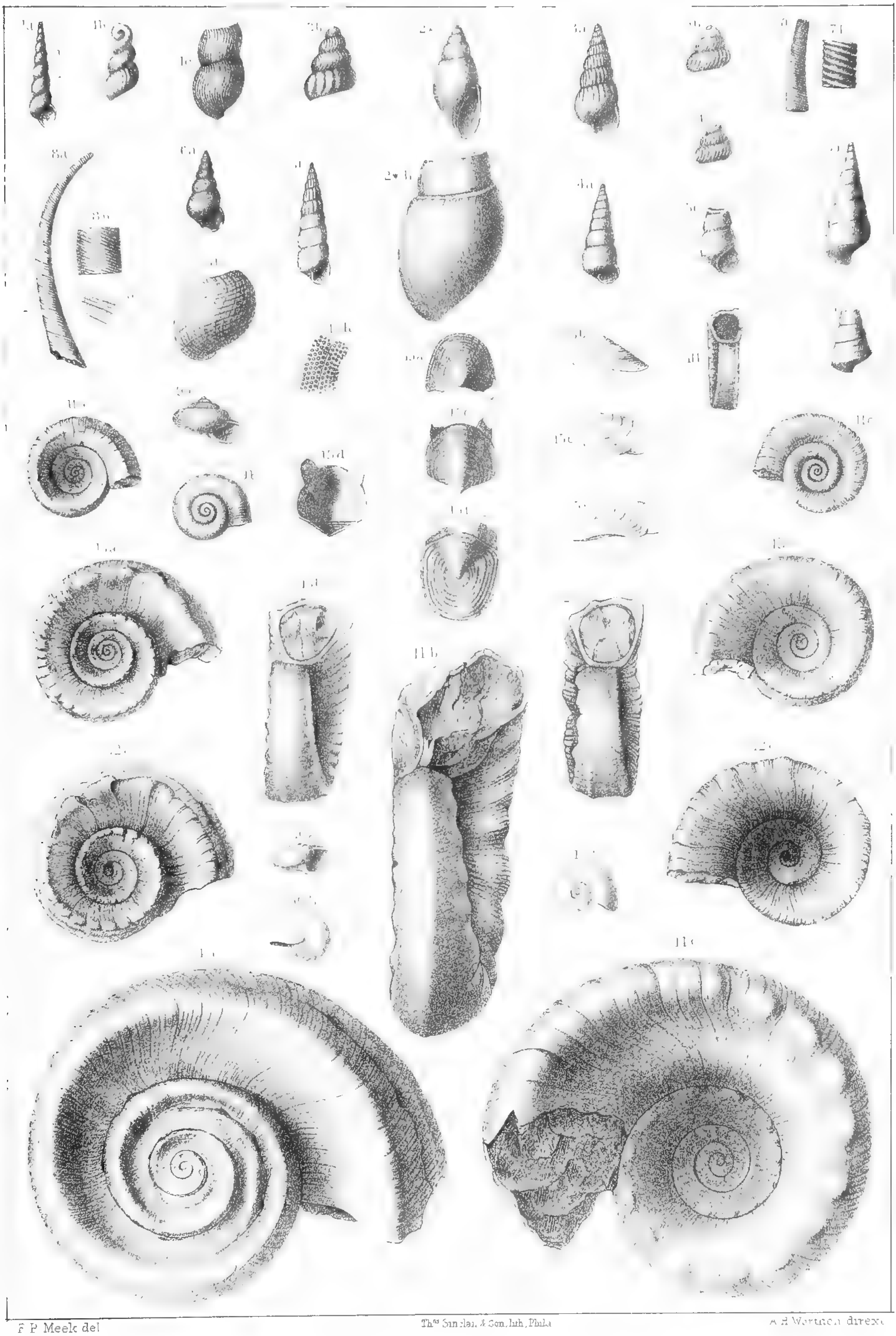

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PLATE XXX.

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Fig. 1.	GONIATITE (sp. undet)	
Fig. 2.	NAUTILUS LATUS	608
Fig. 3.	NAUTILUS PLANOVOLVIS ?	
Fig. 4.	ORTHOCERAS RUSHENSIS ?	612
Fig. 5.	ORTHOCERAS (sp. undet)	
Fig. 6.	PLEUROTOMARIA GURLEYI	

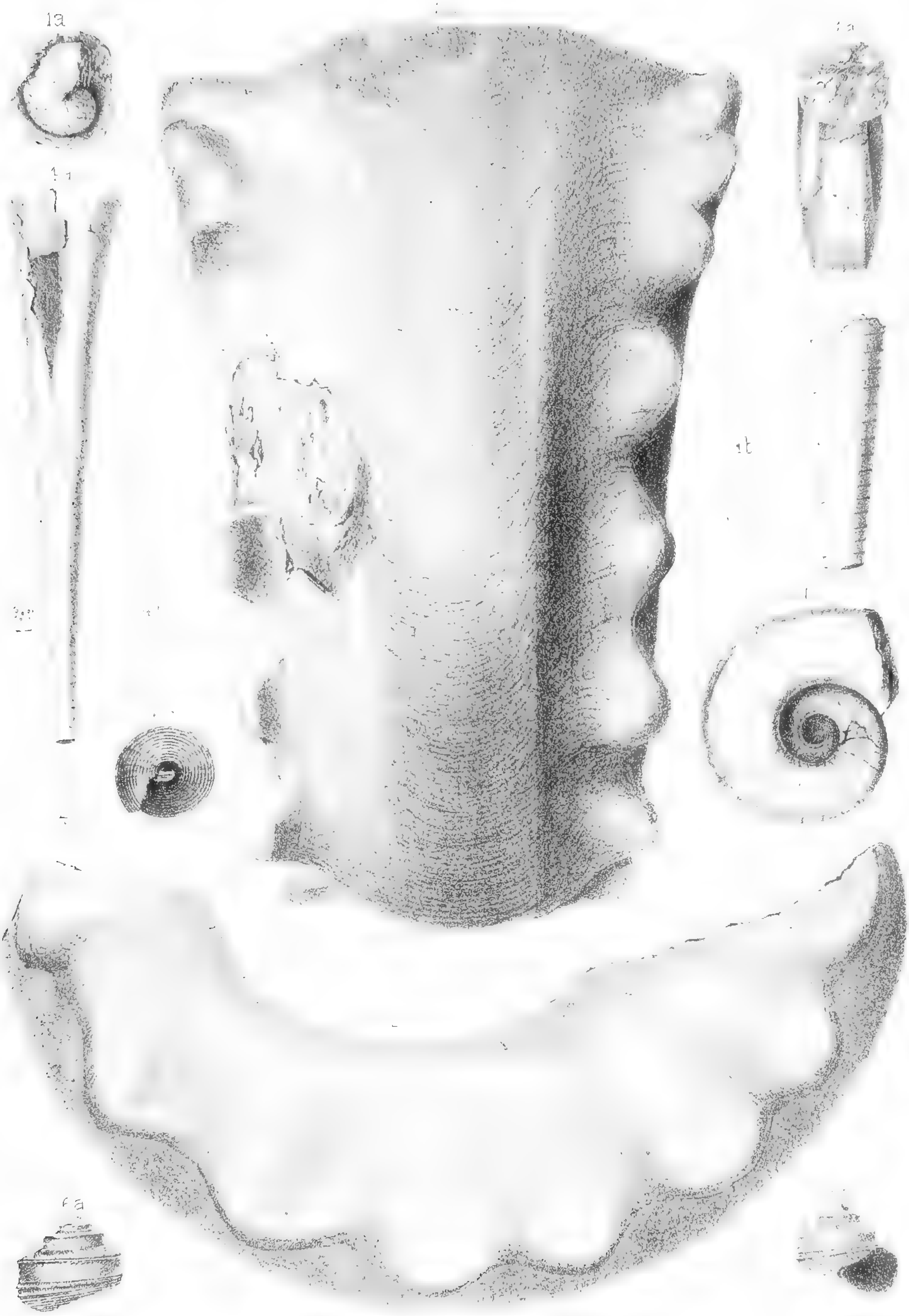

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PLATE XXXI.

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Fig. 1	NAUTILUS LASALLENSIS	610
Fig. 2.	GONIATITES COMPACTUS	611

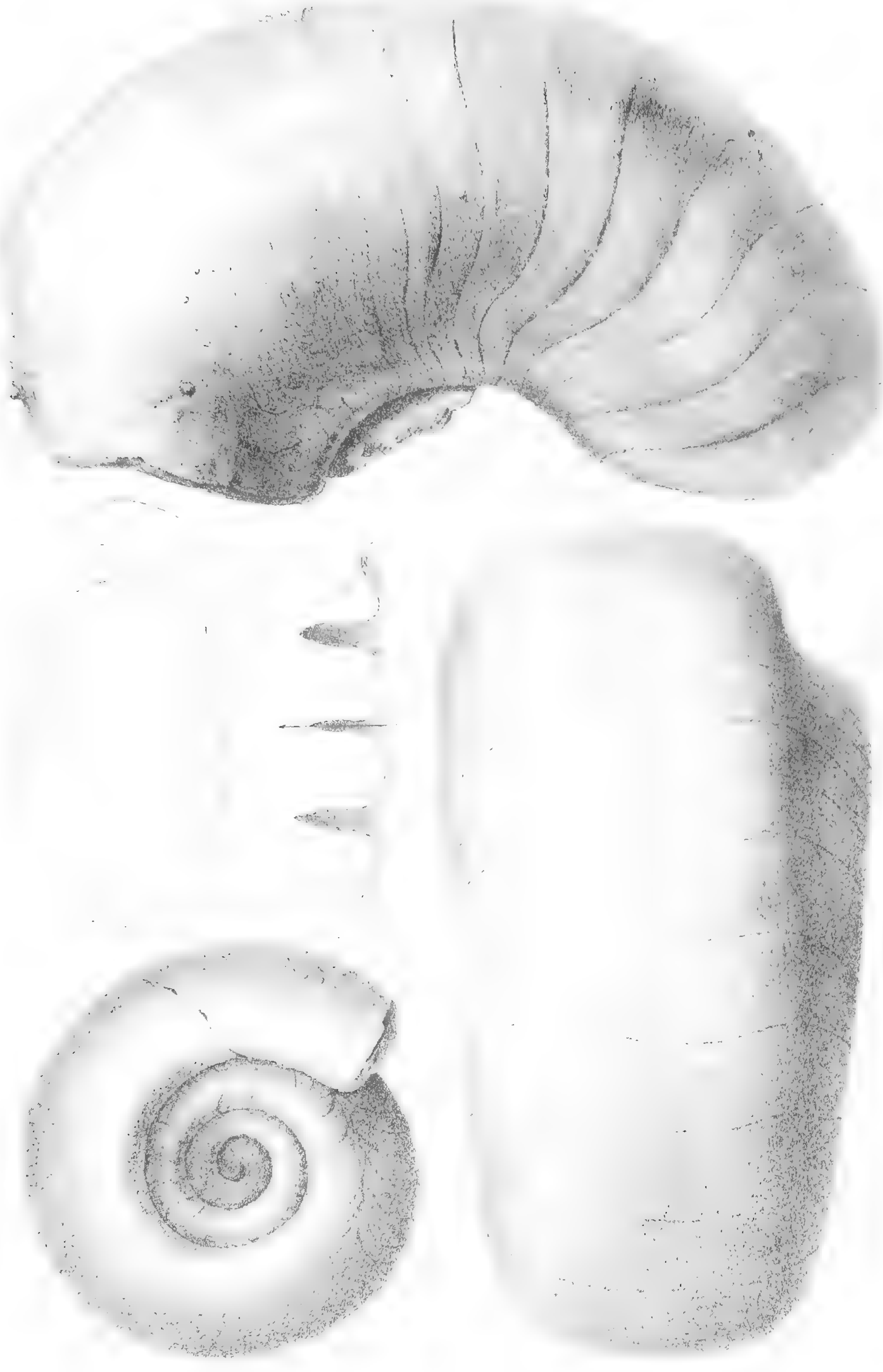

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Fig. 1.	DITHYROCARIS CARBONARIUS	618
Fig. 2.	NAUTILUS WINSLOWI	609
Fig. 3.	PHILLIPSIA SCITULA	612
Fig. 4	PHILLIPSIA SANGAMONENSIS	615

GEOLOGICAL SURVEY OF ILLINOIS

CARBONIFEROUS. MISCELLANEOUS.

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